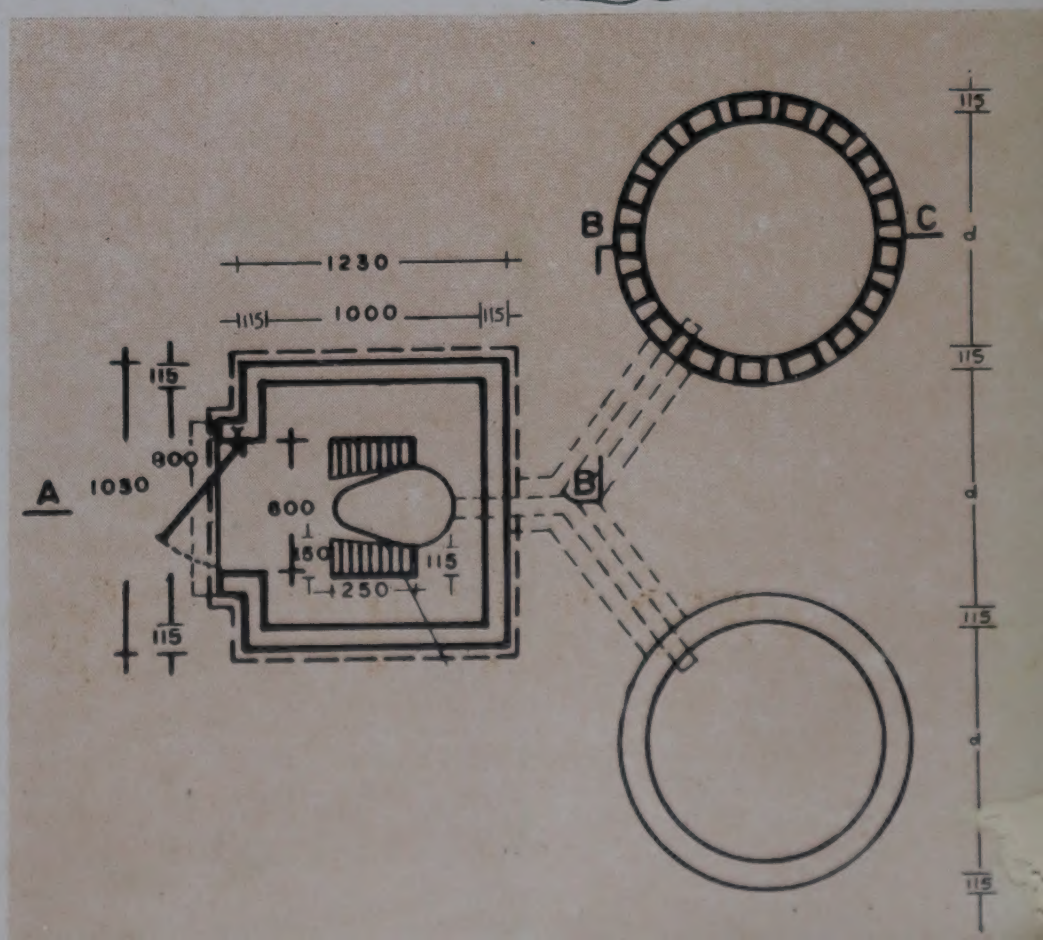
Government of India/UNICEF/UNDP PROJECT IND/84/016 On Rural Sanitation

Report Of The Committee On Design Criteria For Pour-Flush Waterseal Latrines In Rural Communities Of India

The Technology Advisory Group-India March 1985



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GOVERNMENT OF INDIA/UNICEF/UNDP PROJECT IND/84/016
ON RURAL SANITATION

REPORT OF THE COMMITTEE

ON

DESIGN CRITERIA FOR POUR-FLUSH WATERSEAL LATRINES IN RURAL COMMUNITIES OF INDIA

THE TECHNOLOGY ADVISORY GROUP-INDIA

MARCH 1985

ACRONYMS AND ABBREVIATIONS

AC	:	Asbestos cement
AIIHPH	:	All India Institute of Hygiene and Public Health, Calcutta
Cap	:	Capita
CBRI	:	Central Building Research Institute, Roorkee
cm	:	Cement mortar
cm	:	Centimetre
cu	:	Cubic
dia.	:	Diameter
ft	:	Feet
GOI	:	Government of India
GRP	:	Fibre glass reinforced polyester plastic
HDPE	:	High density polyethylene
IRCWD	:	International Reference Centre for Waste Disposal
ISI	:	Indian Standards Institution
m	:	Metre
mm	:	Millimetre
NEERI	:	National Environmental Engineering Research Institute, Nagpur
PVC	:	Polyvinyl chloride
SW	:	Stoneware
TAG	:	Technology Advisory Group of World Bank, Washington on Low Cost Water Supply and Sanitation
TAG (India)	:	Regional Group of TAG for South Asia based in Delhi
UNDP	:	United Nations Development Programme
UNICEF	:	United Nations Children's Fund

INDEX

		Page No.
1.	Introduction	1
2.	Latrine size	2
3.	Pan and trap	3
4.	Connection to leaching pits	3
5.	Inspection chamber	4
6.	Foot-rests	4
7.	Flooring	4
8.	Leach pits	4
	Design of pits	4
	Function of pits	5
	Solids storage volume	6
	Long term infiltration rate	7
	Hydraulic loading	7
	Pathogen destruction	8
	Optimal emptying frequency	8
	Number of pits	8
	Shape	9
	Spacing between two pits	9
	Siting of pits	9
	Distance of leaching pits from existing structures	9
	Location of pits in depressions and water logged areas	10
	Lining of pits	10
9.	Pit cover	11
10.	Removal and utilisation of pit contents	11
11.	Latrine superstructure	

Page No.

12. Community latrines 11
13. Education 11
14. Pollution aspects 12
    Safe distance from drinking water sources 13
    Safe distance from water supply mains 15
15. Summary and design requirements 15
16. Estimates and drawings 15

Annex I—Leach pit design example 16
Annex II—Drawing of sand envelope 19
Annex III—Design requirements of pour-flush latrines in rural areas 20
Annex IV—Estimates and drawings 28

1. Introduction

1.1 Improved sanitation is considered a necessary requirement for socio-economic development and an important element of basic needs of the people. It is also recognised that improvement in sanitary conditions is more effective and at the same time less expensive than any other preventive health measure to combat water-borne and excreta related diseases which account for nearly 80% of sickness in India. With proper disposal of human excreta, these diseases can be brought under control and the entire sanitation situation of the country can be improved. Studies have also established that without proper sanitation, full health benefits of providing safe water supply are not achieved.

1.2 One of the targets of the International Drinking Water Supply and Sanitation Decade (1981-90) in the country is to provide 25% of the rural population with sanitation facilities. Less than 1% of the rural population had access to these facilities at the beginning of the decade. To realise the target, a mass programme of construction of sanitary latrines in rural areas is required to be launched, preceded by feasibility studies to evolve an appropriate low cost design to serve as a sound base for the larger programme.

1.3 Rural latrine schemes have been designed and implemented in different parts of India for over half a century by a number of organisations and institutions. There is, however, no uniformity in latrine designs and specifications. Consequently there is a need to specify optimum requirements for designing suitable low cost sanitary latrines without sacrificing performance and taking into account socio-economic aspects, social and cultural habits, pollution aspects and technical feasibility based on past studies and experience gained.

1.4 Design criteria* were formulated by TAG (India) for pour-flush latrines while preparing feasibility reports for provision of sanitary toilets in urban communities. The income and affordability levels in the rural areas are, however, generally lower than in the urban areas, warranting a search for even lower cost options, necessitating change in engineering design and technology. It involves investigating the use of locally available materials as far as possible which, apart from being cheaper, are likely to blend with the rural environment and lower the dependence on and transport from far-flung urban centres except where absolutely necessary. With this end in view a committee of experts was constituted by TAG (India) to suggest design requirements for pour-flush waterseal latrines to be constructed in rural areas of India. The composition of the committee was :

1. Mr. B.B. Rau, Adviser (PHE), Ministry of Works & Housing, Government of India
2. Mr. R.C. Mangal, Dy. Director, Central Building Research Institute, Roorkee
3. Prof. K.J. Nath, Professor of Environmental Sanitation, All India Institute of Hygiene and Public Health, Calcutta

* TAG (India) publication "Report of the Expert Group on Design Criteria of Pour-Flush Waterseal Latrines".

4. Mr. S.R. Kshirsagar, Scientist & Head, Technology Utilisation & Extension, National Environmental Engineering Research Institute, Nagpur

5. Dr. T.R. Bhaskaran, Consultant, TAG (India), Bangalore

6. Prof. N. Majumder, Consulting Engineer, Calcutta

7. Mr. Philip Wan, Project Coordinator, Environmental Sanitation, UNICEF, Delhi

8. Members of Technology Advisory Group (India).

The recommendations of this committee are given below. While making the recommendations, the experience gained from various latrine programmes in India as well as UNICEF rural sanitation projects in Orissa and Indore (Madhya Pradesh) and results of studies carried out by various institutions and organisations (All India Institute of Hygiene & Public Health, Calcutta, Public Health Institute, Poonamallee, Madras, Planning Research-cum-Action Institute, UP, National Environmental Engineering Research Institute, Nagpur, Central Building Research Institute, Roorkee, Safai Vidyalaya, Ahmedabad and Sulabh International, Patna) in India and abroad were also kept in view.

2. Latrine Size

2.1 In order to find out the optimum size of the latrine cubicle, anthropometric studies were conducted by Central Building Research Institute, Roorkee, by actual measurement of space required for comfortable use and proper functioning in all postures and movements. Four prototype latrines of sizes 90 cm × 110 cm, 80 cm × 100 cm, 75 cm × 100 cm and 75 cm × 90 cm were constructed. The studies revealed that 75 cm × 90 cm is the optimum size from the point of view of cost. Observations made by CBRI are given below :

TABLE-1

Observations on Different Sizes of Latrines

Size of latrine	Observations
1. 75 cm × 90 cm	Most users expressed satisfaction. Only a few exceptionally fat and tall persons felt congested and experienced discomfort.
2. 75 cm × 100 cm	Was acceptable even to tall persons, but exceptionally fat persons felt some discomfort and congestion.
3. 80 cm × 100 cm	Was found to be comfortable by all users.
4. 90 cm × 110 cm	Was found to be very spacious and comfortable but some people felt it too big to afford.

2.2 In the feasibility reports prepared by TAG (India) for urban communities, 75 cm × 90 cm latrine size has been recommended. Latrines of this size have been constructed in a number of towns in the country and these have been well received by the people. However, it was felt that, in the rural areas, where people are used to go for defecation in the open, the people may experience a feeling of congestion and may not use the latrines if the cubicles are very small. In the UNICEF rural projects at Orissa and Indore (Madhya Pradesh), the latrine size provided is 80 cm × 100 cm and these latrines have been well received by the people. Hence, while the minimum size may be 75 cm × 90 cm, it will be desirable to construct latrines of 80 cm × 100 cm size for wider acceptance.

3. Pan and Trap

3.1 After reviewing the studies done for the design of pans and traps by various organisations (governmental and non-governmental) in India, the designs of suitable pans and traps were specified by TAG (India) in the preparation of feasibility study reports for urban areas. Later, the National Swedish Institute for Building Research, Sweden in collaboration with CBRI, Roorkee conducted further studies and slightly modified the designs of pans and traps. Since the performance of these pans has been found to be better, it will be more appropriate to adopt this design. However, since the manufacturers of GRP, PVC or ceramic pans and traps may take some time to switch over to the new design, the designs suggested by TAG (India) earlier may be used till then so that the installation of demonstration units is not delayed.

3.2 Ceramic, cement or mosaic pans are being used extensively in India. Recently pans of GRP and PVC have also been developed and are being used. Ceramic pans cost two and a half to three times more than mosaic ones. GRP and PVC pans are slightly cheaper than ceramic ones in most of the places but are costlier than the mosaic ones. The mosaic and concrete pans are in use in rural areas in many states for the last several decades. It is recommended that for demonstration units to be constructed in the institutions, PVC, GRP or ceramic pans may be used; for the household latrines the choice may be left to the beneficiaries, the government and the donor agencies, if any. After the installation of various types of pans, their relative performance should be studied and conditions observed for 2 to 3 years.

3.3 For mosaic finish pans, the traps will be of cement mortar since manufacture of mosaic finish traps is not possible. For GRP pans, HDPE traps will be used as moulding of GRP traps is difficult. The traps will have 20 mm waterseal and a smooth surface. Experience has shown that where traps of smaller waterseal depth were used, complaints of foul smell coming out from toilets were received. Such complaints also arise due to construction inaccuracies.

4. Connection to Leaching Pits

4.1 Covered channels of bricks, stone or concrete could be adopted wherever is convenient for connecting the toilet pans to pits. Toilet pans could also be connected to the leaching pits with stoneware, cement concrete or non-pressure AC or PVC pipes. Tests conducted on pourflush toilets have shown that optimal pipe diameter should be 75 mm. The bottom of the channel should be circular of 75 mm diameter and of 'U' shape and the surface

should be made smooth with cement punning for better flow. The connecting channels or the pipes should have a gradient ranging between 1:5 to 1:15.

4.2. Where no space is available for construction of individual leach pits, latrines of 2 or 3 houses could be connected to a pair of leaching pits through inspection chamber/chambers constructed at suitable place or places.

5. Inspection Chamber

5.1 A small inspection chamber of 225 mm × 225 mm size should be provided at the bifurcation point where pipes are used for connection. This would facilitate easy cleaning of pipes without resorting to their opening. Chamber should be provided with benching to guide the flow. Surface of the bottom of chamber should be made smooth with cement punning. In the case of channels, Y portion of the drain would serve the purpose of a chamber and cleaning can be done by removing the cover of the drain. The chamber will also be used for providing a stopper of brick or concrete block to that branch of pipe or channel which is not in use.

5.2 The cost analysis should be made of the two alternatives i.e. pipes with a chamber and channel without a chamber and the cheaper alternative should be used. For convenience of cleaning and where sufficient cover over the pipes is not possible, channels will be suitable compared to pipes.

6. Foot-rests

6.1 Foot-rests are required to guide the user to the right position and to provide comfort in the squatting position. The optimum length of each foot-rest should be 250 mm and width 120 mm. The foot-rest should be about 25mm above the floor level. The alignment of the foot-rests should be such that the centre line of both the foot-rests placed on opposite sides of the pan intersect at an angle of about 40° and the apex of the angle lies along the longitudinal central axis of the pan in plan. The back portion of the foot-rests should be raised slightly to give a slope towards the front to provide more comfortable squatting position. Front portion of the foot-rests should be made wider say 150 mm and be as close as possible to the pan so that the children could also sit comfortably. The foot-rests can be of ceramic, cement concrete, mosaic or bricks plastered smooth.

7. Flooring

7.1 Impervious flooring should be provided to prevent moist conditions (which can cause insect breeding). The surface of the floor should be very smooth, sloped slightly towards the pan.

8. Leach Pits

8.1 Design of Leach Pits

8.1.1 Function of Pit

8.1.1.1 Leach pits serve the dual function of: (a) storage and digestion of excreted solids, and (b) infiltration of the waste water liquids. Leach pits are, therefore, to be designed on the basis of the following parameters :

(a) the solids accumulation rate;

(b) the long term infiltration rate of the liquid fraction across the pit soil interface;

(c) the hydraulic loading on the pit;

(d) the minimum period required for effective pathogen destruction; and

(e) the optimal emptying frequency.

8.1.1.2 These parameters are discussed below. The local soil and hydrogeology affect not only (a) and (b) above, but also the structural design of the pit and the magnitude and extent of any ground-water pollution that may result. The position of water table (that is, whether the pit is wet or dry) is also important.

8.1.2 Solids Storage Volume

8.1.2.1 The solids (sludge) accumulation rate is a function of a wide range of variables including water table level, pit age, water and excreta loading rates, microbial conditions in the pit, temperature and local soil conditions and the type of material used for anal cleansing. Data on long term accumulation rates are limited. Studies conducted by various institutions like All India Institute of Hygiene & Public Health, Calcutta, Public Health Institute, Poonamallee (Madras), PRAI, Lucknow (UP) and Indian Council of Medical Research in India show that accumulation rates in pits under different hydrogeological conditions vary from 0.037 to 0.066m^3 per capita per year. Latest (1984) study carried out by the Department of Environmental Sciences and Engineering, School of Public Health, University of North Carolina at Chapel Hill in collaboration with Technology Advisory Group under UNDP Interregional Project INT/81/047 in West Bengal and Bihar (India) indicates that the average sludge accumulation rate in leach pits is 0.03m^3 per capita per year. Until further data are available, the pits should be designed on the rates given in Table 2.

TABLE 2

Recommended Design Values for Solids Accumulation Rates

Material used for anal cleansing	Solids accumulation rate (m^3 per capita per annum)
	Dry pits*
Water	0.04
Soft paper	0.05

8.1.2.2 In wet pits where the ground-water table is above the bottom of the pit and in soils with low permeability like clay, there will be a progressive build-up of liquid in the pit due to the reduction of effective area and the lesser driving head for percolation and ultimately the liquid build-up will reach the level of inlet to the pit. Hence in such hydrogeological conditions, the life of the pit is governed by the total liquid and solid accumulation in the pit. In

* Unsaturated soil conditions i.e. where the distance between the bottom of pit and the maximum groundwater level throughout the year is 2 metres or more.

general, solids accumulation in wet pits due to the higher rate of microbial activity, lower than those in dry pits. However, recent work carried out in India has shown that, in low permeability soils, wet pits designed for five years or less, interval between successive desludgings, surcharge to such an extent that their capacity has to be increased to prevent flooding (larger wet pits require less capacity than dry pits, partly because of the improved digestion under wet conditions and partly because the surcharging effect appears to stabilise). Tentative design recommendations for the wet pits (that is, where the pit bottom is, less than 2 metres from the maximum ground-water level or pit is submerged in water) are given in Table 3.

TABLE 3

Design Values for Wet Pits

Desludings interval (years)	Volume (m^3 per capita per annum)
2	0.095
3	0.067
4	0.051
5	0.041
6	0.035

8.1.3 Long Term Infiltration Rate

8.1.3.1 On account of clogging of soil pores around the leach pits, infiltrative capacity of the soil is always less than the percolative capacity. The long term infiltrative capacity of the soil should, therefore, be based on the crust tests* done on a wide range of different soils. The recommended design values of the long term infiltrative capacity can be derived for typical soil conditions; these values are shown in Table 4.

TABLE 4

Recommended Maximum Effluent Loading Rates for Leach Pits

Soil type	Long term infiltrative loading rate (Litres per sq. metre per day)
1. Sand	50
2. Sandy loam, loams	30
3. Porous silty loams, porous silty clay loams	20
4. Compact silty loams, compact silty clay loams, clay	10

* J. Bouma and J.L. Denning, "Field Measurement of Unsaturated Hydraulic Conductivity by Infiltration. Through Gypsum Crusts," Soil Science Society of America Proceedings, 36 (5), 846, 1972.

8.1.4 Hydraulic Loading

8.1.4.1 The hydraulic loading rate is the total volume of liquids entering the leach pit and is expressed in litres per day, although it is often more convenient to consider per capita loadings (in litres per capita per day, lcd). Researches done in India show that the pan and trap proposed to be used for pour-flush latrines require one and a half to two litres of water for flushing excreta through the trap into the leach pit. Where anal cleansing is done by water, this may account for even upto 1.5 litres of additional water. The total water requirement (for flushing and anal cleansing) may, therefore, be three to four litres per usage. Another factor of importance is the number of times the toilet is used by a person for excretion and urination. The toilet should also be flushed (water requirement may be even upto one litre) when only urine is passed to prevent or reduce odour release due to ammonia which is produced from urea very quickly in warm climate. Water (about 5 litres) will also be used for washing the latrine floor and cleaning the pan. This water will also enter into the leach pit. The following formula can be used to estimate the volume of waste water per person per day, which will reach the pit :

$$q = N_f (V_w + V_c) + V_f + (aN_uV_v) + V_u^*$$

where,

q = Volume of water reaching the leach pit in litres per capita per day;

N_f = Number of times faeces passed per day (usually two);

V_w = Volume of flushing water, litres per flush (usually 2 litres per usage);

V_c = Volume of Water used for anal cleansing, litres per cleansing (usually 1.5 litres per cleansing);

V_f = Volume of faeces passed, lcd (approximately equivalent to the wet weight of faeces in Kg/day; typical values lie between 0.25 and 0.35);

a = 1 if the toilet is flushed after urine is only passed; =0 if it is not;

N_u = Number of times urine passed per day by a person;

V_v = Volume of water used for flushing when only urine is passed (usually one litre per day);

V_u = Volume of urine produced, lcd (typically 1.2).

8.1.5 Pathogen Destruction

8.1.5.1 Excreted pathogens-viruses, bacteria, protozoa and helminths—eventually die in the leach pit or in the surrounding soil. Work carried out in different parts of the world has shown that anaerobic digestion of night soil at ambient temperatures in night soil storage pits will result in substantial reduction of all pathogens within a period of 30 days, although few helmenthic eggs may survive. Research undertaken by the World Bank** has shown that after one year all viruses, bacteria, and protozoa will be

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* Technical note (draft) on "The Design of Pour-Flush Toilet" by D. Duncan Mara, TAG, World Bank, Washington.

** R.G. Feachem, D.J. Bradley, H. Garelick and D.D. Mara, "Sanitation and Disease : Health Aspects of Excreta and Waste Water Management", John Wiley & Sons, 1983.

dead, as will most helminths with the exception of Asacris Lumbricoides (the large human round-worm) although only a few Asacris ova will be viable after this time. However, if the leach pit is wet, Asacris survival is enhanced. After about one and a half years of storage in the pit, it will not be hazardous to handle the contents of the pit and use it as a manure.

8.1.6 Optimal Emptying Frequency

8.1.6.1 The minimum acceptable design interval between successive manual desludgings of each twin leach pit could be one and a half years. But to provide a reasonable degree of operational flexibility, a two year storage volume should be provided. The volume so calculated must be checked to determine whether it provides sufficient infiltrative surface area; if it does not, then additional volume should be provided. A free space of atleast 150 mm must be left at the top of pit above the invert level of the pipe or drain. This design approach, which is illustrated in the example given in annex-I, ensures that there is sufficient "resting time" while the pit is essentially empty for the regeneration of the infiltrative surface; approximately one month is required for aerobic bacteria to oxidize the compounds responsible for clogging the pit soil interface*, so the infiltrative capacity of the leach pit is restored to close to its original value.

8.2 Number of Pits

8.2.1 Single leach pits are appropriate only if they can be desludged mechanically by a vacuum tanker, since their contents are not pathogen free. Twin leach pits are recommended since the pits are to be desludged manually, as the resting period ensures that material to be removed is not hazardous to handle.

8.2.2 In most of the earlier programmes, only one pit was constructed and the latrine adopter was asked to provide the second pit after the first pit got filled up. Evaluation studies have revealed that by and large the second pit was not constructed by most of the people and after the first pit got filled up, they again started going out in the open for defecation. Hence it is essential that both the pits are built simultaneously.

8.3 Shape

8.3.1 The shape of pit can be circular, square/rectangular or a combination of the two. However, separate circular pits should be constructed wherever feasible as these are more stable and cost less. Where circular pits of standard sizes cannot be constructed due to space constraints, smaller diameter (not less than 750mm) but deeper pits or combined oval pits may be provided.

8.3.2 The ratio of diameter and depth of pit is an important factor in the optimisation of pit dimensions. The greater the depth, more is the cost of excavation, lining and cleaning, while bigger the diameter, more is the cost of cover. The economical depth and diameter ratio should be worked out for every region based on current rates of labour and materials.

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* J. T. Winneburger, P.B. Arnold and P.H. McGauhey, "A Study of Methods of Preventing Failure of Septic Tank Percolation Fields", second annual report to the Federal Housing Authority, Sanitary Engineering Laboratory, University of California, Berkeley, 1962.

8.4 Spacing Between Two Pits

8.4.1 The minimum space between the two pits should be equivalent to at least the effective depth of the pit. Spacing between the two pits can be reduced by providing an impervious barrier like cut off screen or puddle wall. As suggested above if space is a constraint, even a combined oval pit with a partition wall can be provided. Larger leaching area would then be required.

8.5 Siting of Pits

8.5.1 The ideal position of locating the pits is that the pits are placed symmetrically at the backside of the latrine pan. However, if site conditions do not permit this layout, the pits can be placed on the side or even in front of the pan.

8.6 Distance of Leaching Pits from Existing Structure

8.6.1 In many cases, the space available for constructing leaching pits may be small and placement of pits near existing structures may be unavoidable. The digging of pits and subsequent seepage may disturb the soil around the pits. The distance of the leach pits from foundations of existing building depends upon the soil characteristics, depth as well as type of foundation of the building and the depth of the leaching pits. The safe distances in different type of soil and depth of leaching pits for a two storey building as recommended by the CBRI, Roorkee are given in Table-5.

TABLE-5

Type of soil	For pits within premises		For pits outside premises	
	Total depth of pit (in metres)	Distance of pit from the existing structure (in metres)	Total depth of pit (in metres)	Distance of pit from the existing structure (in metres)
Clayey sand (Sand >50%)	1.30	0.22	1.96	0.54
	1.73	0.43	2.27	0.72
	2.05	0.60	2.56	0.88
Sandy clay (clay and silt >50%)	1.30	0.32	1.96	0.80
	1.73	0.60	2.27	1.06
	2.05	0.88	2.56	1.30

8.6.2 However, in cases where the leaching pits are quite close to the existing building foundation, the opening in the brick work lining of the leaching pit may be reduced to 12-15 mm.

8.7 Location of Pits in Depressions or Water-Logged Areas

8.7.1 Location of pits should be avoided, as far as possible, in depressions where waste water or rain water is likely to remain collected all round and over the pits. If it cannot be avoided or the pits are to be constructed adjacent to ponds or tanks, the top of pits

should be raised by 0.6 to 0.8 m above the ground level and earth filling be done all round the pits upto a distance of 1.5 m right upto the pit top. The raising of pit may necessitate raising of the latrine floor also.

8.8 Lining of Pits

8.8.1 The pits should be lined. Lining could be with honey-comb brick work, stones or laterite bricks or ferro-cement. Burnt clay or concrete rings with perforations could also be used. Lining could be done with treated bamboos or planks or tar drums also, but the life of such lining is limited.

8.8.2 The lining in bricks would be in honey-comb brick work with appropriate number of rings of solid brick layer at suitable intervals in between. The thickness of brick lining should be 75 mm for pits within premises and 115 mm for pits outside the premises. The brick work should be either in cement mortar 1 : 6 or lime or any other suitable mortar of equivalent strength. As an alternative if it is economical, the lining could be done in 115 mm width in pits within premises with honey-comb brick work with no mortar; however, solid rings would be in cement mortar 1 : 6. In stone masonry, the vertical joints should be kept open i.e. should not have mortar. The size of holes in honey-comb brick work will be the height of brick layer and one third length of the brick. However, in case the soil is sandy or sand envelope is provided or where the foundation of the building is very close to the pit, the width of openings should be reduced to 12 to 15 mm i.e. vertical joints of brick work should not have any mortar. A ring of solid brick layer in cement mortar 1 : 6—115 mm width in 75 mm thick lining and 225 mm in 115 thick lining-should be provided as foundation below the bottom of pit. A solid layer of brick work in mortar may also be provided over the foundation layer. The lining above the invert level of drain or pipe (entering the pits) upto the bottom of pit cover will also be in solid brick work i.e. without any openings.

8.8.3 In black cotton soils, a vertical fill 300 mm in width with gravel or ballast should be provided all round the pit outside the lining.

9. Pit Cover

9.1 Where the space permits, the leaching pits should be constructed within the premises of the households as it would be economical as well as facilitate their cleaning. However, where, due to space constraint, construction of pits within the premises may not be possible, pits can be constructed in places like lanes, streets and roads. The cover for pits located inside the premises should be designed for bearing a live load of 200 Kg/m^2, while for pits outside the premises, they should be designed for the expected loads. The covers for pits located under the road where heavy vehicular traffic can pass over them, may be designed for a wheel load of 6820 Kg for class B loading on a tyre contact area of 37.5 cm $\times$ 20 cm.

9.2 The pit covers can be of reinforced cement concrete, stone slabs, treated wooden planks or bamboos. Selection of material for pit covers will depend upon the cost, availability and site conditions.

10. Removal and Utilisation of Pit Contents

10.1 After one pit is filled up, the flow is diverted to the second pit. The contents of the filled up pit are then allowed to digest and remain undisturbed for a period of at least one and a half years, when it will not be hazardous to handle the digested humus.

10.2 The limited analysis carried out at AIIHPH, Calcutta has shown that the humus contains 1 to 3 percent nitrogen, about 0.8 to 1 percent phosphorus and 0.8 to 1 percent potash on dry weight basis. The NPK contents contribute to the fertilising value and the humus provides the much needed food for soil microbes, improves the water holding capacity of soil and serves as a good soil conditioner.

11. Latrine Superstructure

11.1 Superstructure over the latrine in the institutions like schools, primary health centres etc. should be in harmony with the other structures of the institution but at the same time its design should be such that its cost is as low as possible.

11.2 It has been experienced that if the latrines in the households are not provided with a superstructure, most of the householders do not construct it and consequently do not also use the latrine; they continue going out for defecation in the open. Hence it is advisable that a superstructure should be provided simultaneously with the latrine in the household. It may be a low cost structure and be in conformity with the type of the construction of the house. The superstructure may be one of the following types, where a concrete or brick superstructure is unaffordable :

(i) Mud walls with thatched or tiled roof;

(ii) Thatch or 'Arhar'* stick walls with thatched roof;

(iii) Date palm or bamboo matting with bamboo frame and thatched roof; and

(iv) In hills, walls of slates or small stone pieces and roof of slates.

12. Community Latrines

12.1 Properly maintained community latrines preferably a latrine for a group of houses could be provided for the households where space for construction of individual latrines is not available. Number of seats to be provided may be determined on the basis of one seat for every 10 persons in case of shared latrines and 20 persons in case of community latrines.

12.2 As far as the institutions are concerned, under the GOI/UNICEF/UNDP Rural Sanitation Project, 15 users latrine may be provided in non-residential schools and primary health centres; 10 users latrine in Aanganwadis, Panchayat offices and other institutions is considered adequate because use of latrine in these places will be casual.

13. Education

13.1 It has been observed that even after the construction of latrine in the household, all the members of the family do not use the latrine. The pan is not cleaned, resulting in

* A species of lentil grown in India.

the development of black spots and calcarious deposits. For flushing, usually 1.5 to 2 litres of water is required; but since the householder does not keep a can of the required capacity, the flushing is normally done by buckets. It is, therefore, very essential that the people are educated in using and properly maintaining the latrines. Every household getting the latrine should be supplied with (i) a brush having a long handle forcleaning the pan; (ii) a can of 2 litre capacity for flushing; and (iii) a set of instructions for proper use and maintenance of the latrine. Since in rural areas the households do not have tap connection and even where there is a connection, the supply is only for a few hours, a small container say of 25 litre capacity to store water for ablution and flushing may also be supplied to every latrine adopter to be kept outside the latrine but near it. This container can be filled in daily by the woman of the house when she is free from other household work. It will ensure easy availability of water for latrine use and flushing. Similarly, a container of about 100 litres capacity may be provided in the institutions.

14. Pollution Aspects

14.1. One of the important aspects of on-site excreta disposal as envisaged in the low cost sanitation programme is pollution of the ground-water and piped water supplies located close to the disposal pits. The fundamental requirement for prevention of pollution of both surface and ground-water is a proper design and construction of the latrines in such a manner that under no circumstances, will there be any water logging around the latrine or ponding of the pit will happen due to overflow of pit contents. A critical review of literature on this aspect of the problem has been prepared recently by IRCWD and was also discussed at the meeting of the International Working Group on Pollution Studies at New Delhi. This* provides valuable guidelines for the implementation of the on-site sanitation programme with minimum risk of pollution of ground-water supplies and distribution systems.

14.2. Ground-water pollution by on-site excreta disposal system depends on the nature of occurrence of ground-water. Ground-water occurs in aquifers which are classified as either confined or unconfined.

14.3. When water is drawn from confined aquifers which are relatively deep, on-site excreta disposal poses no pollution hazard, provided the well construction is carried out properly to preclude direct flow from unconfined zones and sanitarily protected to prevent surface contamination. Under these conditions the main concern is the water distribution system which can well be taken care of by ensuring certain minimum distance between pit and distribution pipes, and protecting vulnerable sections from external contamination.

14.4. The unconfined and marginally confined aquifers are the main concern from the point of view of pollution hazard. Here, two situations are met with, viz., i) where the pit is located entirely in the unsaturated zone; and ii) where the pit is located partly in the unsaturated zone and partly in the saturated zone. The studies carried out in USA, India and elsewhere have shown that in alluvial soil (with predominance of silt mixed with clay and fine sand) where pits are located in the unsaturated zone, the risk of bacterial pollution is minimal provided the bottom of the pit is at least 2 metres above the maximum ground-water level and the hydraulic loading in pits does not exceed 50mm/day. Where the pit extends in the saturated zone, the pollution travel depends mainly on the velocity of ground-water. In alluvial soil, the distance of

* W. John Lewis, Stephen S.D. Foster, Bohumil S. Drasar, "The Risk of Groundwater Pollution by On-Site Sanitation in Developing Countries", a literature review; IRCWD—Report No. 01/82.

pollution travel is equivalent to about 10 days travel of ground-water. The velocity can be found out for different soil conditions. It was also observed that with the continued usage of the pit, clogging of the soil around the pit takes place resulting in the regression of pollution plume which ultimately stabilises at about 1 metre distance.

14.5 These studies clearly indicate that in continuous unsaturated, unconsolidated strata greater than 2 metre depth (with size of soil less than 1 mm) beneath the base of the latrine, the risk of ground-water pollution due to faecal contamination would be minimal, provided the hydraulic loading in the pit does not exceed 50 mm/day.

14.6 The observations carried out by the Technology Advisory Group (TAG) in Gujarat, Tamil Nadu and Bihar States in India seem to be in conformity with the foregoing statement.

14.7 Among the chemical pollutants arising from the leaching pits, 'nitrate' is significant. The increase in the nitrate content of ground-water, arising from the leach pits depends on the extent of aerobic activity, dilution etc. Periodic monitoring of ground-water is thus important in this connection.

14.8 Proper information/investigation of hydrogeological conditions of the sites where the pits are to be located are prerequisites for the implementation of the programme in order that the pollution risk to ground-water and water distribution pipes is minimal. Even in unfavourable hydrogeological conditions such as coarse soil, high ground-water velocity and high water table, these systems can be used provided certain modifications and precautions are taken, such as providing an envelope of fine sand of effective size not more than 0.2 mm and a minimum thickness of 500 mm all round the pit and the bottom sealed off by any impervious material such as fine clay, puddle clay or polythene sheet. (For sand envelope see drawing at annex-II). These modifications are also applicable where soil beneath the pit is less than 2 m to water table. In high water table conditions, the inlet to the pit should be kept at least one metre above the maximum ground-water level. This condition may necessitate raising of the latrine floor.

14.9 In conditions such as rock with fissures, chalk formations, old root channels, pollution can flow to very long distances. These conditions demand careful investigation and necessary modifications of the system or adoption of alternative sanitary systems.

14.10 It is desirable to periodically monitor the quality of ground-water in the area where the programme is implemented. The monitoring programme should cover periodical sampling of ground-water and analysis for faecal coliforms and nitrate.

14.11 Guidelines for field staff to keep the water pollution risk minimal are given below :

14.11.1 Safe Distance from Drinking Water Sources

14.11.1.1 In dry pits or unsaturated soil conditions, i.e. where the distance between the bottom of the pit and the maximum ground-water level throughout the year is 2 m and more :

(a) the pits can be located at a minimum distance of 3m from the drinking water sources such as tubewells and dugwells if the effective size (E.S.) of the soil is 0.2 mm or less; and

(b) for coarser soils (with E.S. greater than 0.2 mm), the same distance can be maintained if the bottom of the pit is sealed off by an impervious material such as puddle clay or plastic sheet and 500 mm thick envelope of fine sand of 0.2 mm effective size is provided all round the pit.

14.11.1.2 In wet pit or saturated soil conditions i.e. where the distance between the bottom of the pit and the maximum ground-water level during any part of the year is less than 2m:

(a) The pits can be located at a minimum distance of 10 m from the drinking water sources such as tubewells and dug wells, if the E.S. of the soil is 0.2 mm or less; and

(b) for coarser soils (with E.S. more than 0.2 mm), minimum distance of 10 m can be maintained if the pit is sealed off by an impervious material such as puddle clay or plastic sheet and a 500 mm thick envelope of fine sand of 0.2 mm effective size is provided all round the pit.

14.11.1.3 The above cases are summarised in the following matrix (table) :

Case	Distance between the bottom of the pit and the maximum ground-water level	Effective size of the formation soil	Minimum horizontal distance of separation	Modification needed
1.	$\geq$ 2m	$\leq$ 0.2 mm (fine sand, clay & silt)	3m	None
2.	$\geq$ 2m	$>$ 0.2mm (coarse sand)	3m	Provide envelope of sand and impermeable pit bottom
3.	$<$ 2m	$>$ 0.2mm (coarse sand)	10m	Provide envelope of sand and impermeable pit bottom
4.	$<$ 2m	$\leq$ 0.2mm (fine sand, clay & silt)	10m	None

14.11.1.4 In both the cases of paras 14.11.1.1 (b) and 14.11.1.2 (b) :

(a) the sand envelope should be taken at least upto 2m above the possible highest maximum water level and edges chamfered to see that no water stagnates on the top of the sand filling.

(b) where the bottom of the pit is submerged below the maximum ground-water level :

(i) the top of the pits should be raised above the ground level, if necessary, so that the inlet pipe into the pit is at least 0.75m above the maximum ground-water level;

(ii) the sand envelope is taken upto 0.3 m above the top of the inlet pipe and confined suitably to exclude any surface drainage including rain water directly entering the sand envelope;

(iii) in mound type latrines, 1 m high earth filling should be provided for atleast 0.25 m beyond the sand envelope with the edges chamfered to lead away the rain or surface water; and

(iv) the honey-comb brick work for the pit lining should be substituted by brick work in cement mortar 1 : 6 with open vertical joints i.e. without mortar.

14.11.1.5 Where sand is not available economically, local soil of effective size of 0.2 mm can also be used.

14.11.2 Safe Distance from Water Supply Mains

14.11.2.1 Lateral distance between the leach pit and the water main should be at least 3 m provided the water table does not rise during any part of the year above the pit bottom and the inlet of pipe or drain to the leach pit is below the level of water main. If the water table rises above the bottom of the pit, the safe lateral distance should be kept as 8 m. If this cannot be achieved, the pipes should be completely encased to a length of atleast 3 m on either side of the pit.

14.11.2.2 When the pits are located either under the foot-path or under the road, or the water supply main is within a distance of 3 m from the pits, the invert of the inlet pipe should be kept at least 1 m below the ground level. This would ensure that the liquid level in the pits does not reach the level of the water main as the water mains are generally laid at 0.9 m depth.

14.11.2.3 The water pipe should not cut across the pit, but where this is unavoidable, the water pipe should be completely encased for a length of 3 m on either side of the pit including the portion across the pit to prevent infiltration or exfiltration.

15. Summary of Design Requirement

15.1 A summary of design guidelines which affords a certain amount of flexibility to the designer is given in annex III.

16. Estimates and Drawings

16.1 Estimates and drawings of various units of pour-flush latrine are in annex IV.

Leach Pit Design Example

Design example : Twin leach pits (6 users)

1. **Assumptions**
   (a) Water needed for anal cleansing per use per member of the family is 1½ litres;
   (b) The latrine is used for excretion twice a day by each family member;
   (c) Water needed for flushing after every use is 2 litres;
   (d) Water needed for flushing urine (only when urine is passed) is one litre per member per day;
   (e) Average urine+excreta production per day per member is 1½ litres;
   (f) The water table remains 2 metres or more below ground level throughout the year;
   (g) The local soil is sandy loam or loam; and
   (h) The pits have been designed for 2 years capacity.

2. The solution is as follows :
   (a) Calculate the waste water flow in lcd

$$q = N_f (V_w + V_c) + (V_f + V_u) + (aN_u V_v)$$
$$= 2\ (2+1.5) + 1.5 + (1 \times 1 \times 1)$$
$$= 9.5 \text{ lcd}$$

   (b) Calculate the total waste water flow (Q) in litres per day (adding 5 litres for latrine floor washing and pan cleaning).

$$Q = 6 \times 9.5 + 5 = 62 \text{ litres per day}$$

   (c) Assuming a pit of 900 mm internal diameter (inside lining 75mm thick with brick on edge and effective depth 800mm, check for infiltrative surface area (A_f); this is given by :

$$A_f = \pi\ dh$$

where d is the external diameter and h is the effective depth of the pit.

$$A_f = \pi \times 1.05 \times 0.8$$
$$= 2.64 m^2$$

If the soil is sandy loam or loam, the infiltrative area required is 62/30 i.e. $2.07 m^2$; hence the infiltrative area provided is sufficient.

   (d) Calculate the solids storage volume (V), assuming solids accumulation rate as $0.04 m^3$ per capita per year for a dry pit with water being used for anal cleansing and for a desludging interval of 2 years and a household size of 6 persons :

$$V = 0.04 \times 2 \times 6$$
$$= 0.48 m^3$$

Volume of pit proposed $=\pi x\frac{1}{4}x0.9x0.9x0.8$

$=0.51m^3$

Hence pit proposed has the sufficient storage capacity.

(e) Allowing a free space of, say 0.225m, the dimensions of pit are as follows :

Internal diameter	900mm
Total depth	1025mm

Since the pit bottom is more than 2m above the maximum ground-water table, the pit will function in dry conditions.

Twin leaching pits (10 users)

$Q=10\times9.5+5$

$=100$ litres per day.

Assuming a pit of internal dia. of 1000mm and effective depth 1000mm,

$A_j=\pi\times1.15\times1$

$=3.61m^2$

If the soil is sandy loam or loam, the infiltrative area required is $100/30=3.33m^2$; hence the infiltrative area provided is sufficient.

Solid storage volume reqd. $=0.04\times2\times10$

$=0.8m^3$

Volume of pit proposed $=\pi\times\frac{1}{4}\times1\times1\times1$

$=0.79m^3$

Hence the pit proposed has sufficient storage capacity.

Twin leaching pits (15 users)

$Q=15\times9.5+5$

$=147.5$ litres per day

Assuming a pit of internal dia. of 1250mm and effective depth 1100mm,

$A_j=\pi\times1.4\times1.1 \quad =4.84m^2$

If the soil is sandy loam or loam, the infiltrative area required is $147.5/30=4.92m^2$; hence the infiltrative area provided is almost the same as required.

Solid storage volume reqd. $=0.04\times2\times15 \quad =1.2m^3$

Volume of pit proposed $=\pi\times\frac{1}{4}\times1.25\times1.25\times1.1 \quad =1.35m^3$

Hence the pit proposed has sufficient storage capacity.
Allowing a free space of, say 0.225m, the dimensions of pit are as follows :

Internal diameter	1250mm
Total depth	1325mm

Design example : Wet pits for 6 users

The ground-water table is 50 cm below the ground surface, but all other assumptions are the same as in the above example.

The pit size is determined by taking the sludge accumulation rate from Table-3. Assuming the pit desludging period as 2 years,

$$\text{Volume of pit} = 0.095 \times 2 \times 6$$
$$= 1.14 \text{ m}^3$$

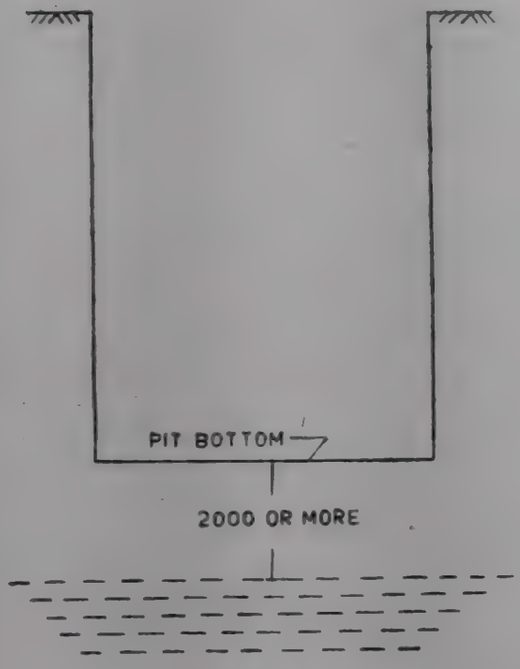
Allowing a free board of 0.225m, pit dimensions come as follows :

Internal diameter	1250 mm
Total depth	1150 mm

DRY PIT

WATER TABLE 2000 OR MORE BELOW BOTTOM OF PIT (MAXIMUM GROUND WATER LEVEL REACHED ANY TIME DURING THE YEAR)

NO SAND ENVELOPE OR BOTTOM SEALING NEEDED

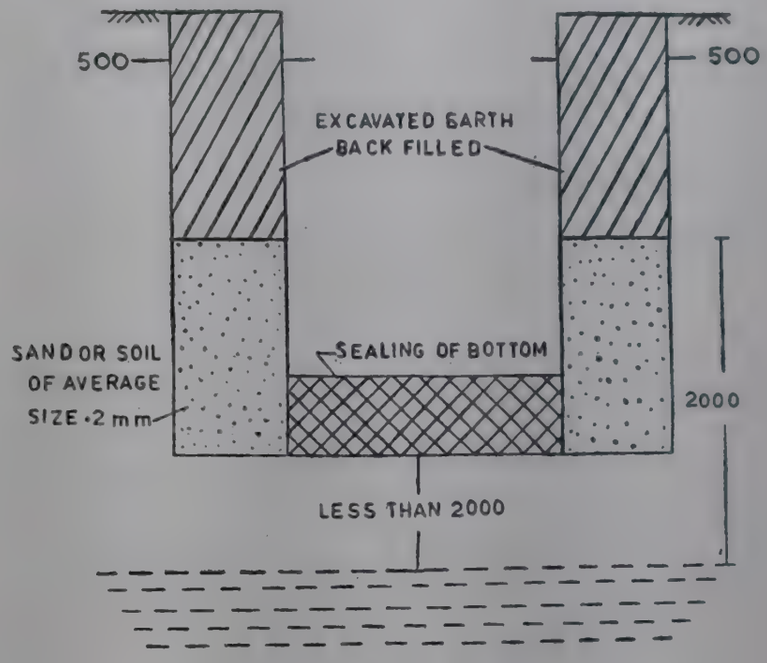


CASE_1

DRY PIT

WATER TABLE LESS THAN 2000 BELOW THE BOTTOM OF PIT (MAXIMUM GROUND WATER LEVEL REACHED ANY TIME DURING THE YEAR)

SAND OR SOIL ENVELOPE ALLROUND THE PIT UPTO 2000 HEIGHT FROM MAXIMUM WATER-TABLE AND BOTTOM TO BE SEALED

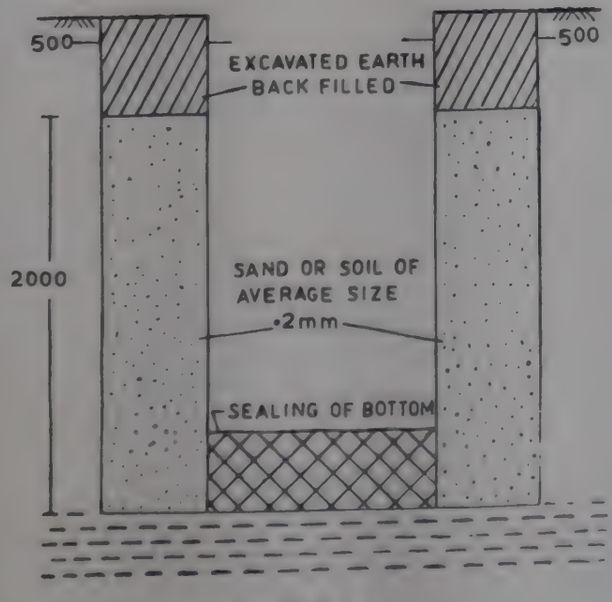


CASE_2

WET PIT

WATER TABLE AT THE BOTTOM OF THE PIT (MAXIMUM GROUND WATER LEVEL REACHED ANY TIME DURING THE YEAR)

SAND OR SOIL ENVELOPE ALLROUND THE PIT UP-TO 2000 HEIGHT FROM HIGHEST WATER TABLE AND SEALING OF BOTTOM NEEDED

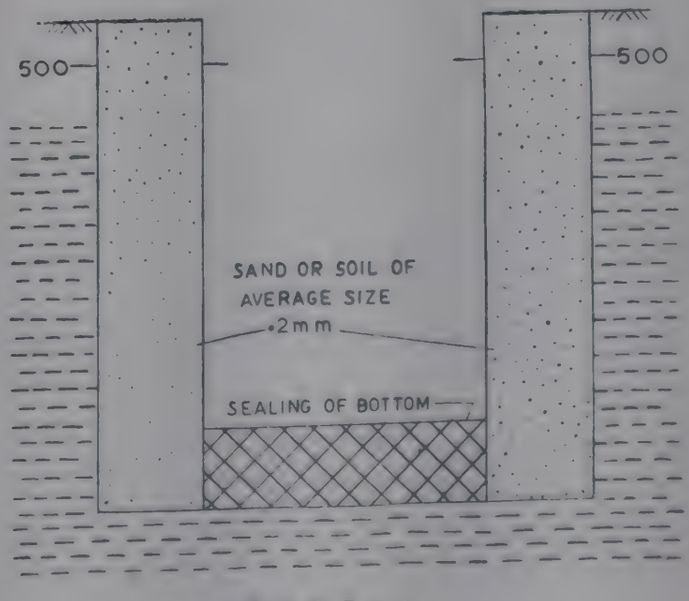


CASE_3

WET PIT

WATER TABLE ABOVE THE BOTTOM OF THE PIT (MAXIMUM GROUND WATER LEVEL REACHED ANY TIME DURING THE YEAR)

SAND ENVELOPE ALLROUND THE PIT AND SEALING OF BOTTOM NEEDED



CASE_4

NOTE_ WHEN ENVELOPE IS PROVIDED, LINING OF PITS SHOULD NOT BE IN HONEY COMB BRICK WORK BUT SHOULD BE IN MASONRY WITH VERTICAL JOINTS OPEN (WITHOUT MORTAR) 12 TO 15mm WIDE

ALL DIMENSIONS IN MM

Design Requirements for Pour-Flush Waterseal Latrines in Rural Areas

Item	Requirement	Other Options	Remarks
1. Latrine platform			
a) Size	Minimum 750×900 mm but desirable 800×1000 mm	900×900	—
b) Foundation	225×75 mm ballast mixed with sand duly compacted and over it one brick layer 225 mm in width and another layer of brick 115 mm in width; brick work to be in cement mortar 1:6 (for stone masonry it should be modified suitably)		Foundation to be modified suitably to suit site conditions. Stone or any other suitable material may be used where use of bricks is not economical
c) Plinth	Brick work in cement mortar 1:6, 115 mm in width and 225 mm in height (for stone masonry to be modified suitably)	Brick work in mud mortar 225 mm in width (foundation to be modified suitably)	225 mm width should be adopted only when it is economical for superstructure in brick work in mud mortar
2. Latrine pan			
a) Width of front portion of pan	140 mm		
b) Width of back portion of the pan	220 mm		
c) Vertical drop in front wall of the pan	70 mm		
d) Rear wall of the pan inclination, horizontal off-set to the rear of trap opening	22.5 mm		Plumb line should fall at 15 mm away from the centre of the hole in trap opening

Item	Requirement	Other Options	Remarks
e) Rear vertical drop	310 mm	—	—
f) Horizontal length	440 mm	—	—
g) Slope of base of pan to horizontal	25°	—	—
h) Dia. of outlet	75 mm	—	—
i) Interior surface	Smooth and durable	—	—
j) Construction material	GRP, PVC, ceramic, mosaic polished	—	Ceramic to be used where economical than GRP and PVC
k) Front portion of pan	Circular (70 mm radius)	—	—
l) Back portion of pan	Circular (110 mm radius)	—	—
m) Base	Circular (30 mm radius)	—	—
n) Shape	As per drawing no. 1 (annex IV)	—	—
3. Waterseal trap			
a) Depth of waterseal	20 mm	—	—
b) Diameter		—	—
—inlet	75 mm		Should have a socket on inlet side. Socket size to suit the outlet of pan
—outlet	75 mm		
c) Placement	Exactly horizontal	—	When trap placed exactly horizontal, it should have 20 mm water-seal

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Item	Requirement	Other Options	Remarks
d) Material	PVC, HDPE, ceramic, cement mortar (Smooth finish)	—	—
e) Length	About 280 mm (from centre of inlet end to centre of outlet end)	—	—
f) Shape	As shown in drawing no. 1 (annex IV)	—	—
4. Connecting pipe or channel to pit			
a) Material	Stoneware, concrete, AC or PVC pipes; channel in brick work in cement mortar with top closed with bricks jointed in mud mortar and covered with earth	Burnt clay pipes, channel in stone masonry	
b) Size of pipe	75 mm	100 mm	—
c) Size of channel	115 mm × 75 mm	—	Base of channel should be circular and 'U' shape
d) Surface	Impervious, durable and smooth	—	—
e) Slope	1 in 10	1 in 5 to 1 in 15	—
5. Inspection or junction chamber at bifurcation point	—	—	Not necessary where channel is provided
a) Effective size	225 mm × 225 mm	—	—
b) Cover	Removable cement concrete or stone	Treated wooden planks	—
c) Interior surface	Impervious, durable and smooth	—	—

Item	Requirement	Other Options	Remarks
d) Bottom	Should have benching to guide the flow	—	—
6. Foot-rests			
a) Size	250 mm × 120 mm (corner rounded)	—	Foot-rests should be close to pan and front portion should be wider.
b) Thickness	25 mm above floor level	—	—
c) Material	Bricks (plastered smooth), cement concrete, or mosaic	Ceramic	—
7. Leaching pit			
a) Sludge accumulation rate under dry conditions	0.04 m^3 per capita per year	—	—
b) Sludge accumulation rate under dry conditions	0.095 to 0.035 m^3 per capita per year	—	Depends on pit-desludging interval (years) (see table 3)
c) Long term infiltrative loading rate	50 to 10 litres per m^2 per day	—	Depends upon the type of soil (see table 4)
d) Year of service	2	3	—
e) Number of pits	2	—	Both pits to be constructed simultaneously but to be used alternately

Item	Requirement	Other Options	Remarks
f) Minimum spacing between two pits	Effective depth	—	May be relaxed by providing an impervious barrier like cut off screen or puddle wall
g) Minimum diameter	750 mm	—	The depth of pits to be modified suitably to get required cubical contents
h) Shape	Circular	Square, oval or rectangular	Combined pit in case space is a constraints
i) Emptying of pit	1½ years after pit is taken out of service	—	—
j) Minimum free board	150 mm	—	—
k) Lining of interior of pit	Burnt clay rings, honey-comb brick work (75 mm width in cement mortar 1 : 6; 115 mm width dry joints) with appropriate number of solid rings of brick layer in between in cement mortar 1 : 6; top 225 mm in height above invert level of pipe or channel will be in solid brick work in cement mortar 1 : 6 and a ring of solid brick layer in cement mortar 1 : 6 below the bottom of the pit as foundation (115 mm width in 75 mm thick lining and 225 mm in 115 mm thick lining); over the foundation, a solid layer of brick work in cement mortar 1 : 6; pit lining top to be plastered in cement mortar 1: 6	Perforated cement concrete rings, laterite bricks, stone	The size of holes in honey-comb brick work will be the height of brick layer X one third length of brick but in case soil is sandy or sand envelope is provided, lining will not be in honey-combing but will have vertical joints dry (joint width to be 12 to 15 mm). In clayey soils either vertical fill 300 mm in width with gravel or ballast be provided all round the pit lining

Item	Requirement	Other Options	Remarks
			be provided. Pit lining top to be plastered to obtain level surface for proper fitting of pit cover
l) Pit cover	Reinforced cement concrete slab or dome, stone slab	Other suitable material such as treated wooden planks or bamboos	Top of pit should be about 75mm above the ground level. In places, where stone ballast is costly, brick ballast for the manufacture of cement concrete slab may be used if its use is economical after suitable modification in the design. Use of reinforced brick pit covers may also be considered. Where there is no chance of loads coming over the pits, burnt clay "vat" may be tried as pit cover by putting it upside down with earth cover
8. Latrine flooring	Smooth, impervious and durable. 25mm cement concrete 1:2:4 over 75 mm brick ballast mixed with sand duly compacted; top surface finished smooth with cement punning		Slope towards pan all round. In places where stone ballast is costly, brick ballast may be used
9. Super-structure for institutions	Brick work 115 mm in width in cement mortar 1:6 (if economical brick work may be 225 mm in width in mud mortar); door jambs to be 225 mm in width; inside	Stone masonry, laterite	Superstructure should be in conformity with the structures of the institution

Item	Requirement	Other Options	Remarks
	bottom 300 mm height plastered in cement mortar 1:4 having cement punning; roof of R. C. C., flag stones or G.I. corrugated or A.C. sheets or tiled in harmony with the other structures of the institution; flooring 25 mm cement concrete 1:2:4 over 75 mm brick ballast mixed with sand duly compacted and top surface finished with cement punning; door shutter of black iron sheet with wooden frame or 25 mm thick braced and battened door shutter of suitable country wood; frame (chaukhat) 30 × 30 × 3 mm angle iron (top and bottom need not be provided); outside to be plastered in cement mortar 1:6		
10. Water requirement for flushing	1.5 to 2 litres per use	—	—
11. Other considerations	1. Proper precautions to prevent water pollution	—	—
	2. Proper siting of pits and latrines	—	—
	3. A brush with a long handle and a can of 2 litres capacity to be supplied to each beneficiary. In institutions, a small storage tank of about 100 litres capacity and in households a 25 litre container for storing water outside the latrine but very near to be provided along with the latrine	—	—

Item	Requirement	Other Options	Remarks
12. Type of pan to be used in demonstration units	**Institutions:** GRP, PVC, ceramic pans	—	—
	Households : 1/2 mosaic and the remaining 1/2 GRP, PVC or ceramic pans (ceramic to be used where economical)	—	—

BILL OF QUANTITIES FOR COVERED BRICK DRAIN ONE METRE IN LENGTH

	Item	Quantity
1.	Earthwork in excavation	0.1m³
2.	Refilling of trenches and disposal of surplus earth	Job
3.	Brick work in cement mortar 1 : 6	0.034m³
4.	Brick work in mud mortar	0.017m³
5.	Cement concrete 1 : 3 : 6	0.0016m³
6.	12mm plaster in cement mortar 1 : 4	0.32m²
7.	Making the bed of drain circular as per drawing and plaster surface smooth with cement punning	Job

BILL OF QUANTITIES FOR JUNCTION CHAMBER

	Item	Quantity
1.	Earthwork in excavation	0.06m³
2.	Refilling of trenches and disposal of surplus earth	Job
3.	Cement concrete 1 : 6 : 12	0.02m³
4.	Brick work in cement mortar 1 : 6	0.025m³
5.	Cement concrete 1 : 2 : 4	0.0023m³
6.	12mm plaster in cement mortar 1 : 4	0.11m²
7.	Reinforced cement concrete 1 : 2 : 4 precast slab excluding reinforcement	0.005m³
8.	M.S. bars (reinforcement) in cement concrete slab	0.45kg.
9.	Making the concrete circular as per drawing and surface smooth with cement punning	Job

BILL OF QUANTITIES FOR FOUNDATION AND PLINTH OF HOUSEHOLD LATRINE

Item	*Quantity*
1. Earthwork in excavation	0.21 m^3
2. Refilling of trenches and disposal of surplus earth	Job
3. Brick ballast mixed with sand duly compacted	0.069 m^3
4. Brick work in cement mortar 1:6	0.213 m^3
5. 12mm plaster in cement mortar 1:2	0.12 m^2
6. Making the plaster smooth with cement punning	Job
7. Flooring :	
(a) Brick ballast mixed with sand duly compacted	0.054 m^3
(b) Cement concrete 1:2:4 including cement punning	0.019 m^3
8. Supply and fix latrine pan and trap	1 set

BILL OF QUANTITIES FOR FOUNDATION AND PLINTH OF LATRINE FOR INSTITUTIONS

Item	*Quantity*
1. Earthwork in excavation	0.23 m^3
2. Refilling of trenches and disposal of surplus earth	Job
3. Brick ballast mixed with sand duly compacted	0.078 m^3
4. Brick work in cement mortar 1:6	0.224 m^3
5. 12mm plaster in cement mortar 1:2	0.12 m^2
6. Making the plaster smooth with cement punning	Job
7. Flooring:	
(a) Brick ballast mixed with sand duly compacted	0.054 m^3
(b) Cement concrete 1:2:4 including cement punning	0.019 m^3
8. Supply and fix fibre glass, PVC or ceramic pan and trap	1 set

BILL OF QUANTITIES FOR LEACHING PIT WITH BRICK LINING IN 75MM WIDTH

Item	*Quantity*		
	6 users	10 users	15 users
1. Earthwork in excavation	1.03 m^3	1.45 m^3	2.3 m^3
2. Refilling and disposal of surplus earth	Job	Job	Job
3. Brick work in cement mortar 1:6	0.156 m^3	0.173 m^3	0.247 m^3
4. Honey-comb brick work in cement mortar 1:6	0.106 m^3	0.167 m^3	0.203 m^3
5. Reinforced cement concrete 1:2:4 precast slab excluding reinforcement	0.043 m^3	0.062 m^3	0.116 m^3
6. M.S. steel bars (reinforcement) in slab	4.2 Kg	4.0 Kg	4.2 Kg
7. 12mm plaster in cement mortar 1:6 on top of brick lining	0.23 m^2	0.25 m^2	0.31 m^2

BILL OF QUANTITIES FOR LEACHING PIT WITH BRICK LINING IN 115MM WIDTH

Item	*Quantity*		
	6 users	10 users	15 users
1. Earthwork in excavation	1.33 m^3	1.83 m^3	2.8 m^3
2. Refilling and disposal of surplus earth	Job	Job	Job
3. Brick work in cement mortar 1:6	0.219 m^3	0.24 m^3	0.331 m^3
4. Honey-comb brick work with dry joints (no mortar)	0.211 m^3	0.32 m^3	0.395 m^3
5. Reinforced cement concrete 1:2:4 precast slab excluding reinforcement	0.05 m^3	0.071 m^3	0.129 m^3
6 M.S. steel bars (reinforcement) in slab	4.5 Kg	4.3 Kg	4.4 Kg
7. 12mm plaster in cement mortar 1:6 on top of brick lining	0.37 m^2	0.40 m^2	0.49 m^2

BILL OF QUANTITIES FOR LATRINE SUPERSTRUCTURE (INSTITUTIONS)

Item	*Quantities*
1. Brick work in cement mortar 1:6	0.792 m^3
2. Reinforced cement concrete 1:2:4 excluding reinforcement	0.093 m^3
3. M.S. steel bars (reinforcement)	3.5 Kg.
4. 12 mm plaster in cement mortar 1:4	0.97 m^2
5. Making plaster smooth with cement punning	Job
6. M.S. angle iron 30×30×3 mm for door frame	2.52 Kg.
7. M.S. holdfasts of 10 mm dia bar, 225 mm long	4 nos.
8. 25 mm thick braced and battened door shutter of country wood with iron fittings or black iron sheet with country wood frame door shutter with iron fittings	0.9 m^2 1.8 m^2
9. Painting of door, 2 coats	8.91 m^2
10. 12 mm plaster in cement mortar 1:6	6.5 m^2
11. White washing, 2 coats	9.2 m^2
12. Colour washing, 2 coats	

BILL OF QUANTITIES FOR 100 LITRE CONTAINER

Item	*Quantity*
1. Brick work in cement mortat 1:6	0.15 m^3
2. 12 mm plaster in cement mortar 1:4 (inside)	1.08 m^2
3. 12 mm plaster in cement mortar 1:6 (outside)	1.57 m^2

16701

LABOUR AND MATERIALS REQUIRED FOR HOUSEHOLD LATRINE UPTO PLINTH (PIT HAVING 75 mm THICK BRICK LINING)

		6 users (man-days)	10 users (man-days)	15 users (man-days)
	Labour			
1.	Mason	1.75	2.0	2.25
2.	Mazdoor	4.0	5.0	6.25
3.	Bhisti (water-man)	0.3	0.4	0.5
4.	Blacksmith	0.3	0.3	0.5
	Material			
1.	Bricks	375 nos.	445 nos.	545 nos.
2.	Brick ballast	0.119 m^3	0.12 m^3	0.12 m^3
3.	Stone ballast	0.095 m^3	0.129 m^3	0.226 m^3
4.	Sand	0.322 m^3	0.378 m^3	0.482 m^3
5.	Cement	2 bags	2.4 bags	3.4 bags
6.	Pan and trap	1 set	1 set	1 set
7.	M.S. bars for reinforcement	8.4 Kg.	8.0 Kg.	8.4 Kg.
8.	One brush with a long handle and a can of 2 litre capacity	1 set	1 set	1 set

Note : 6 user latrine with drain 1.5 m length and 10 and 15 users with 2 m length

LABOUR AND MATERIALS REQUIRED FOR INSTITUTION LATRINE (PIT HAVING 75 mm THICK BRICK LINING)

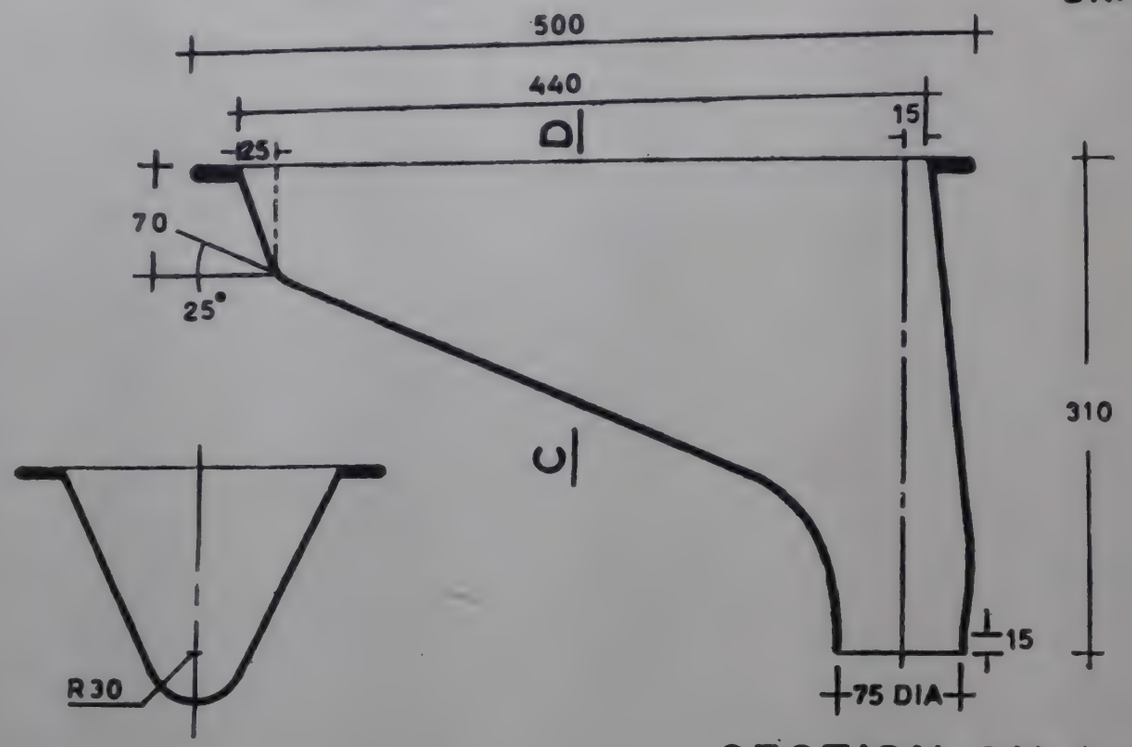
	Item	10 users (man-days)	15 users (man-days)	Superstructure* (man-days)
	Labour			
1.	Mason	2.0	2.25	2.75
2.	Mazdoor	5.0	6.5	4.25
3.	Bhisti (water-man)	0.4	0.5	0.7
4.	Blacksmith	0.3	0.5	0.25
5.	Painter	—	—	0.19
6.	White-washer	—	—	0.16
	Material			
1.	Bricks	450 nos.	550 nos.	470 nos.
2.	Brick ballast	0.128 m^3	0.128 m^3	—
3.	Stone ballast	0.129 m^3	0.226 m^3	0.084 m^3
4.	Sand	0.386 m^3	0.489 m^3	0.518 m^3
5.	Cement	2.5 bags	3.4 bags	3.1 bags
6.	Pan and trap	1 set	1 set	—
7.	Primer	—	—	0.11 litre
8.	Paint	—	—	0.36 litre
9.	White lime	—	—	3.14 Kg.
10.	Colouring material	—	—	0.46 Kg.
11.	M.S. angle iron 30 x 30 x 3mm	—	—	2.52 Kg.
12.	Holdfasts of M.S. bar 10mm dia., 225mm long	—	—	4 nos.
13.	25mm thick braced and battened door of country wood with iron fittings or black iron sheet with country wood frame door shutter with iron fittings	—	—	0.9 m^2
14.	M.S. bars for reinforcement	8.0 Kg	8.4 Kg.	3.5 Kg.
15.	One brush with a long handle and a can of 2 litre capacity	1 set	1 set	—

Note : 1. 2m length of drain is included in the above.

2. For Primary Health Centres and schools, 15 user latrine be provided and for Anganwadi, Panchayat office and other institutions provide 10 user latrines.

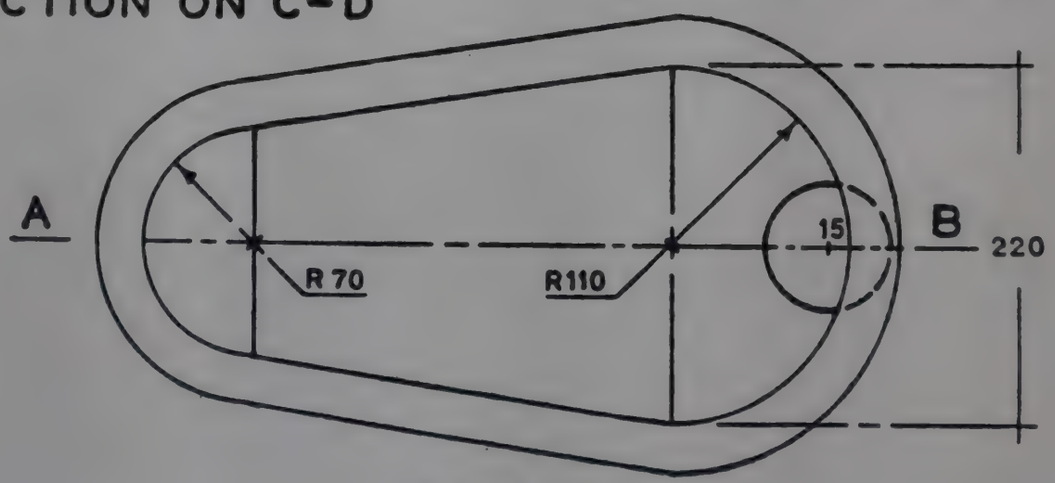
* Includes 100 litre container.

DRAWING No. 1

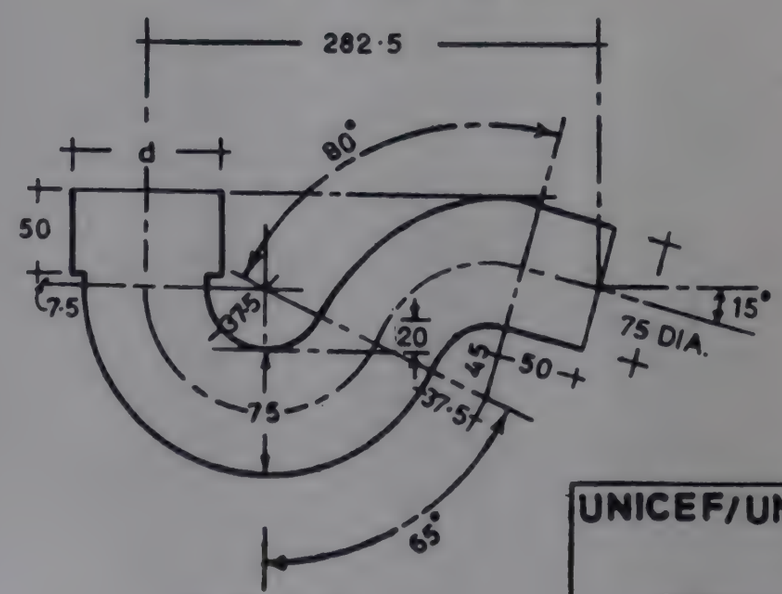


SECTION ON C-D

SECTION ON A-B



PLAN



TRAP

NOTE:
Socket size i.e.'d' of trap to be to suit outlet size of pan

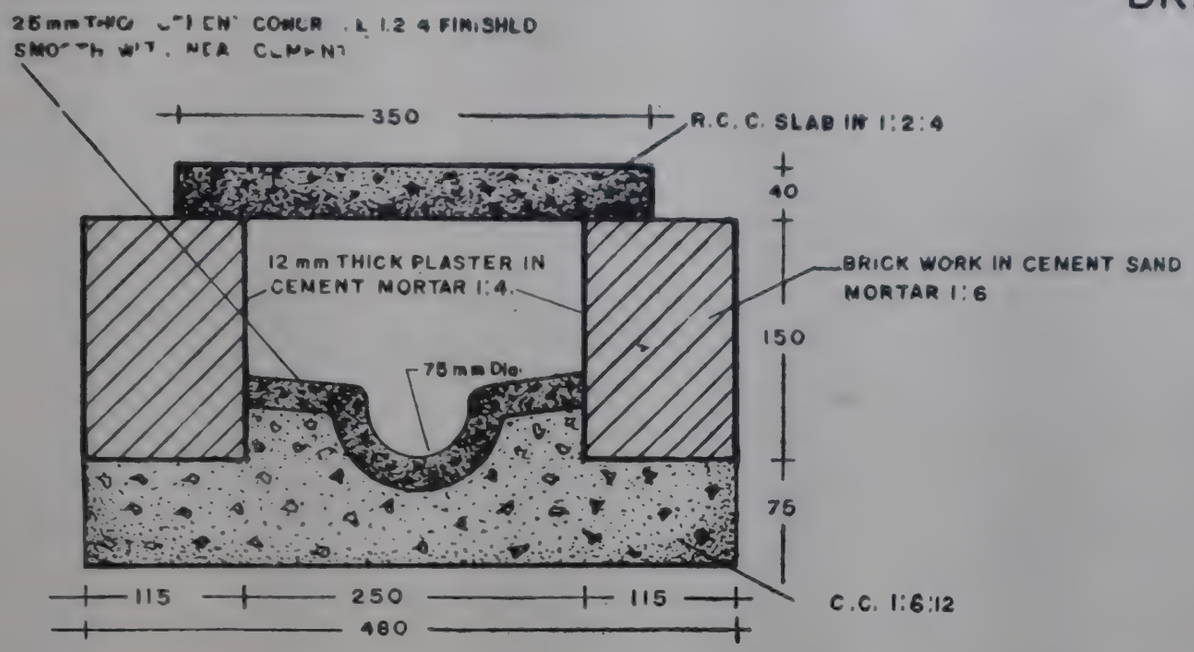
UNICEF/UNDP RURAL SANITATION PROJECT

DETAILS OF PAN & TRAP

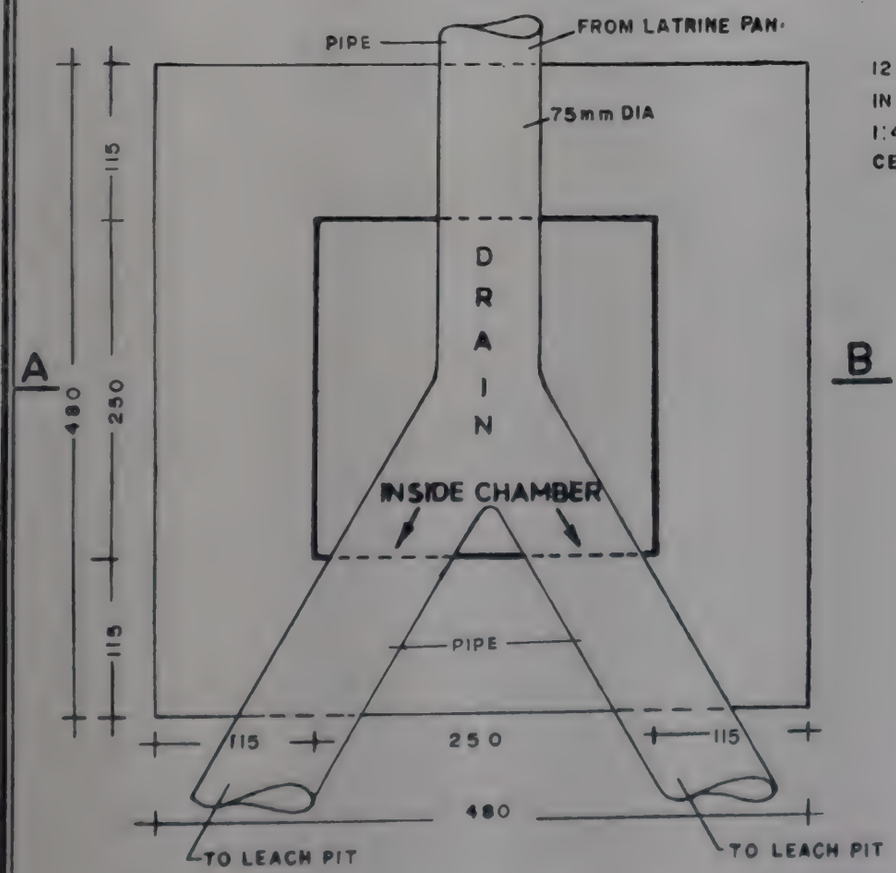
Scale – 1 : 5

ALL DIMENSIONS IN MM

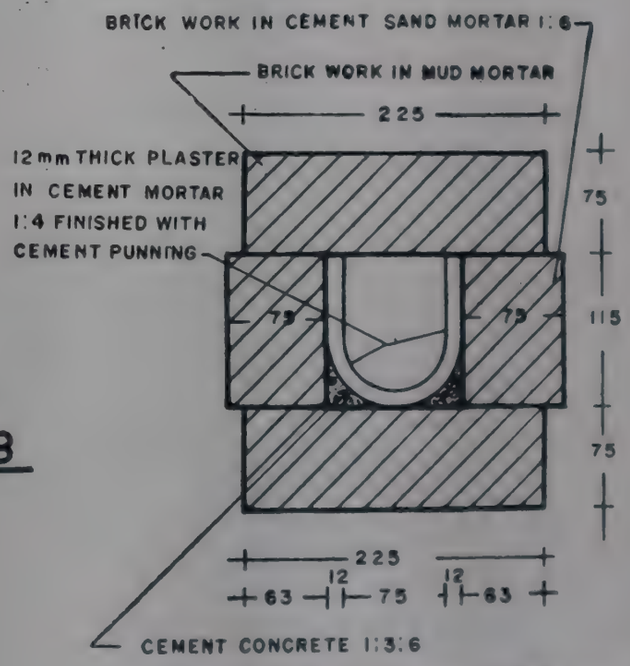
DRAWING No.2



SECTION ON AB



P L A N



DETAILS OF BRICK DRAIN

NOTE CHAMBER TO BE PROVIDED ONLY WHERE PIPES ARE USED

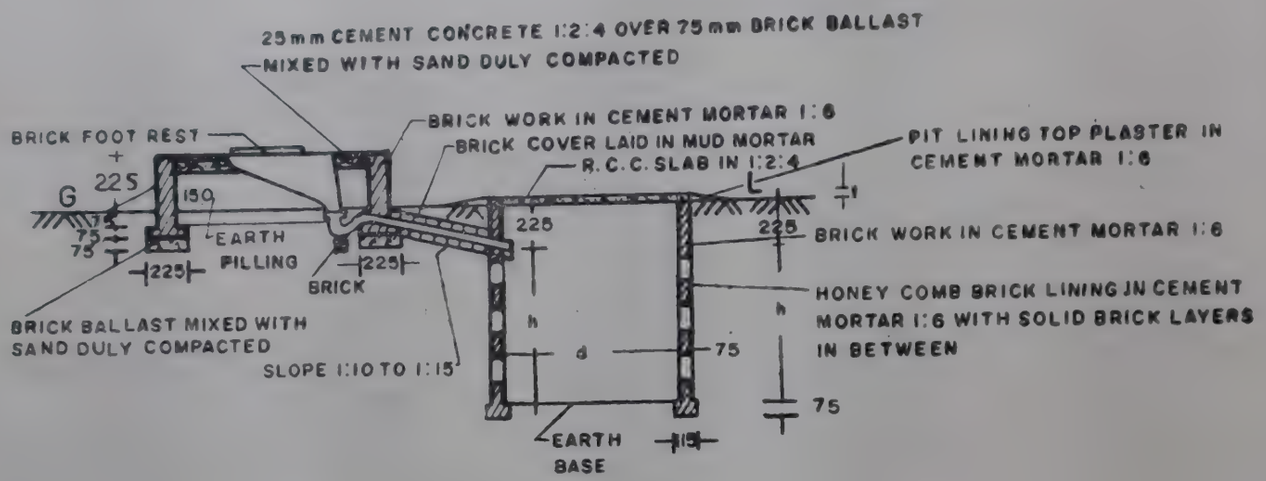
UNICEF/UNDP RURAL SANITATION PROJECT

DETAILS OF JUNCTION CHAMBER & DRAIN

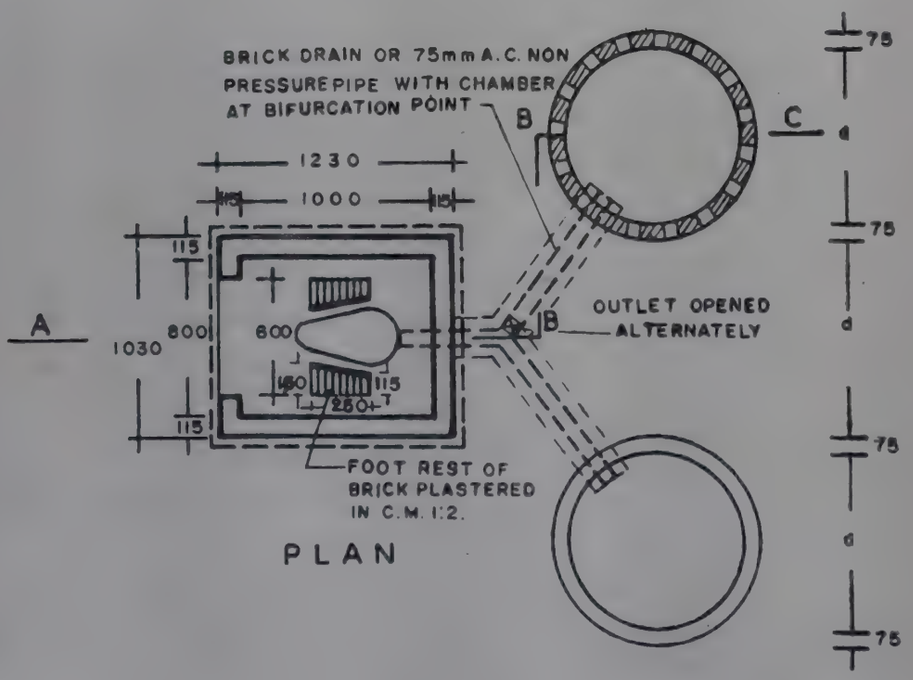
Scale-1:6

ALL DIMENSIONS IN MM

DRAWING No. 3



SECTION ON A-B-C



PLAN

USERS	d	h	t	No. of solid rings (brick layer) and height of centre of ring from pit bottom
6	900	800	50	2,286,518
10	1000	1000	60	2,403,748
15	1250	1100	75	3,403,833,863

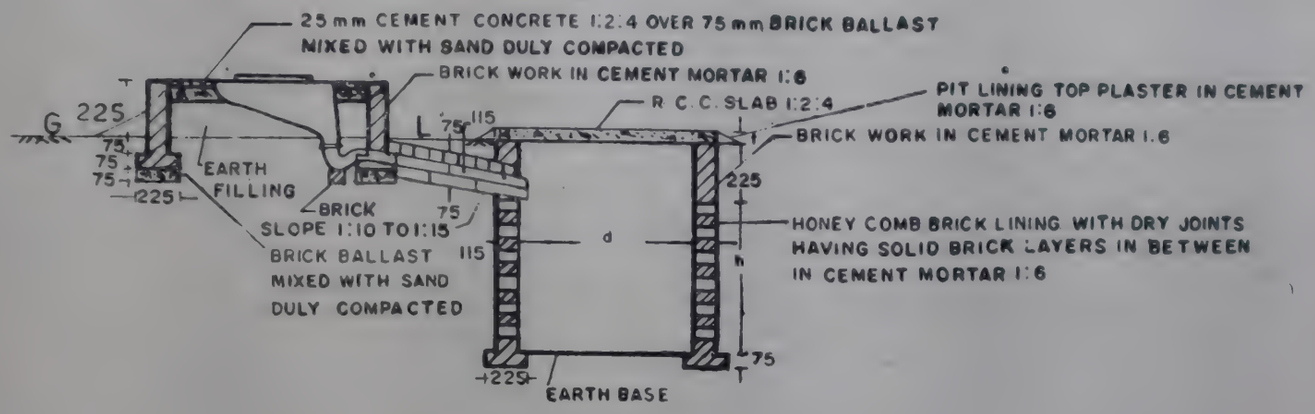
UNICEF/UNDP RURAL SANITATION PROJECT

DESIGN OF WATER-SEAL POUR-FLUSH LATRINE FOR HOUSE HOLDS

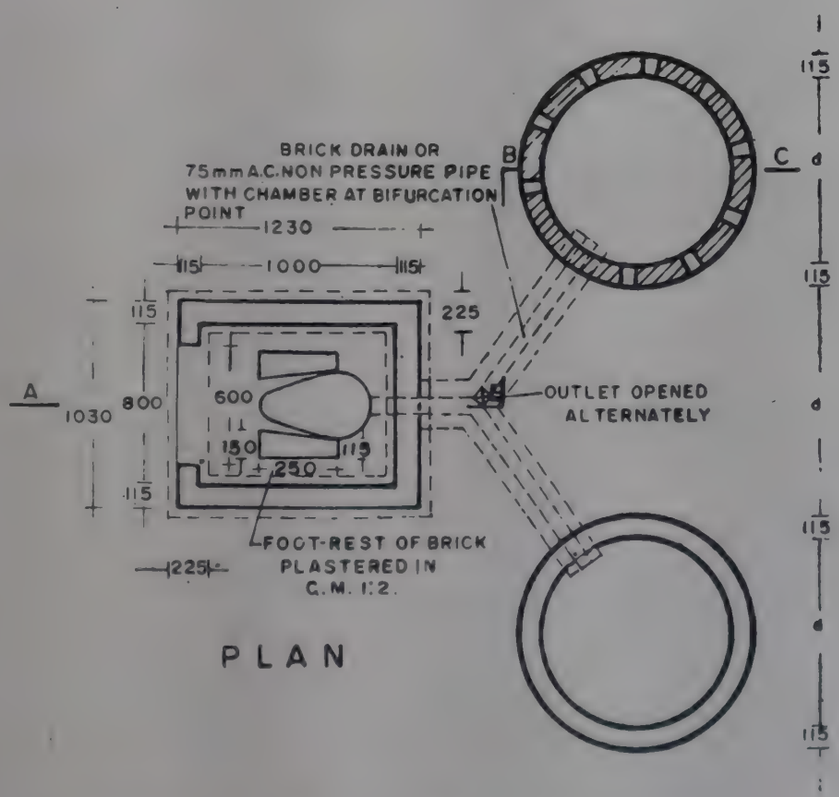
Scale – 1:40

ALL DIMENSIONS IN M M

DRAWING No. 4



SECTION ON
A B-B C



PLAN

NOTE: THIS DESIGN MAY BE ADOPTED ONLY WHEN IT IS ECONOMICAL THAN THE DESIGN SHOWN IN DRAWING No. 3

USERS	d	h	f	No. of solid rings (brick layer) and height of centre of ring from pit bottom.
6	900	600	50	2 ; 338, 563
10	1000	1000	60	2 , 418, 713
15	1250	1100	75	3 , 263, 488, 788

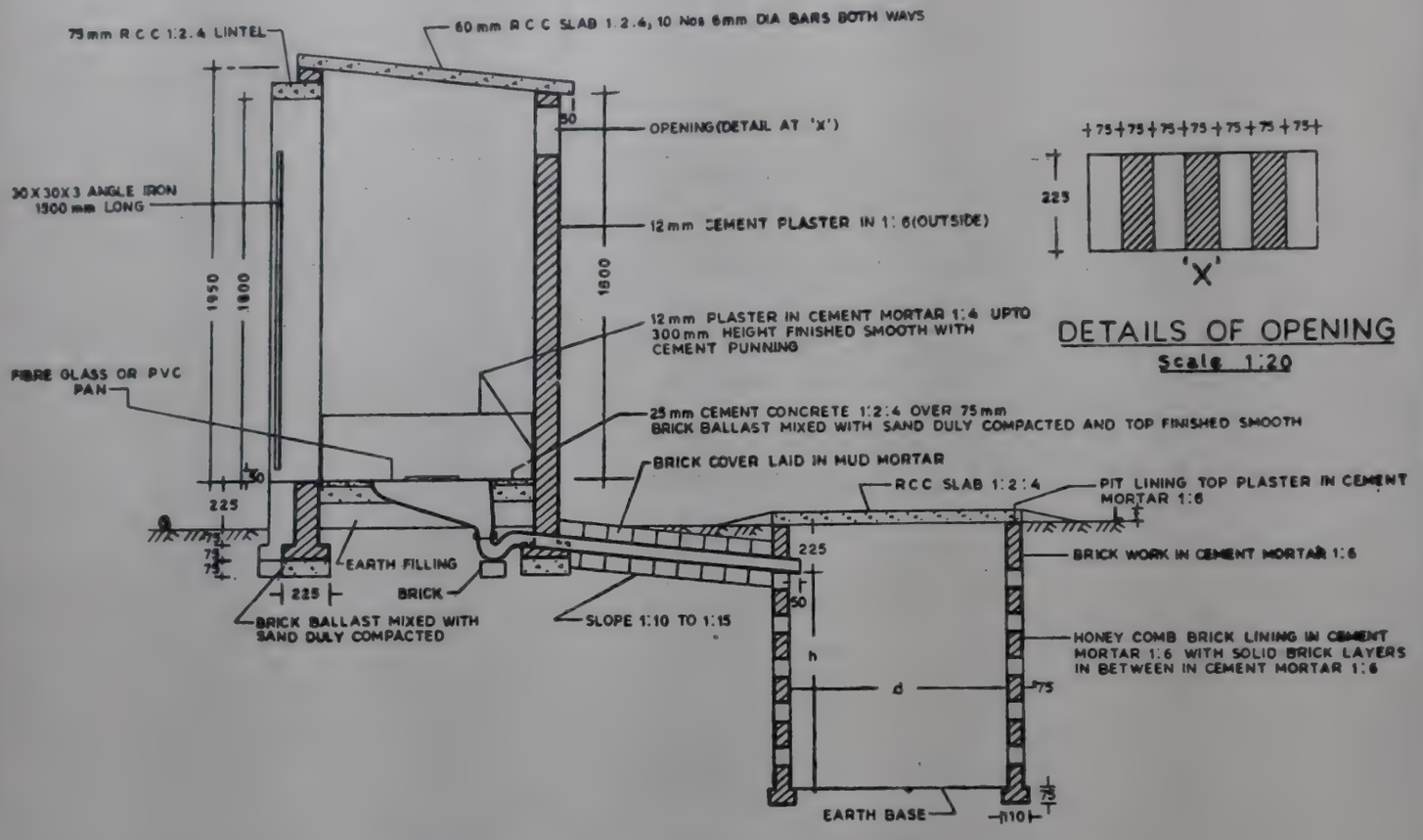
UNICEF/UNDP RURAL SANITATION PROJECT

DESIGN OF WATER-SEAL POUR-FLUSH LATRINE FOR HOUSE-HOLDS

Scale-1:40

ALL DIMENSIONS IN M M

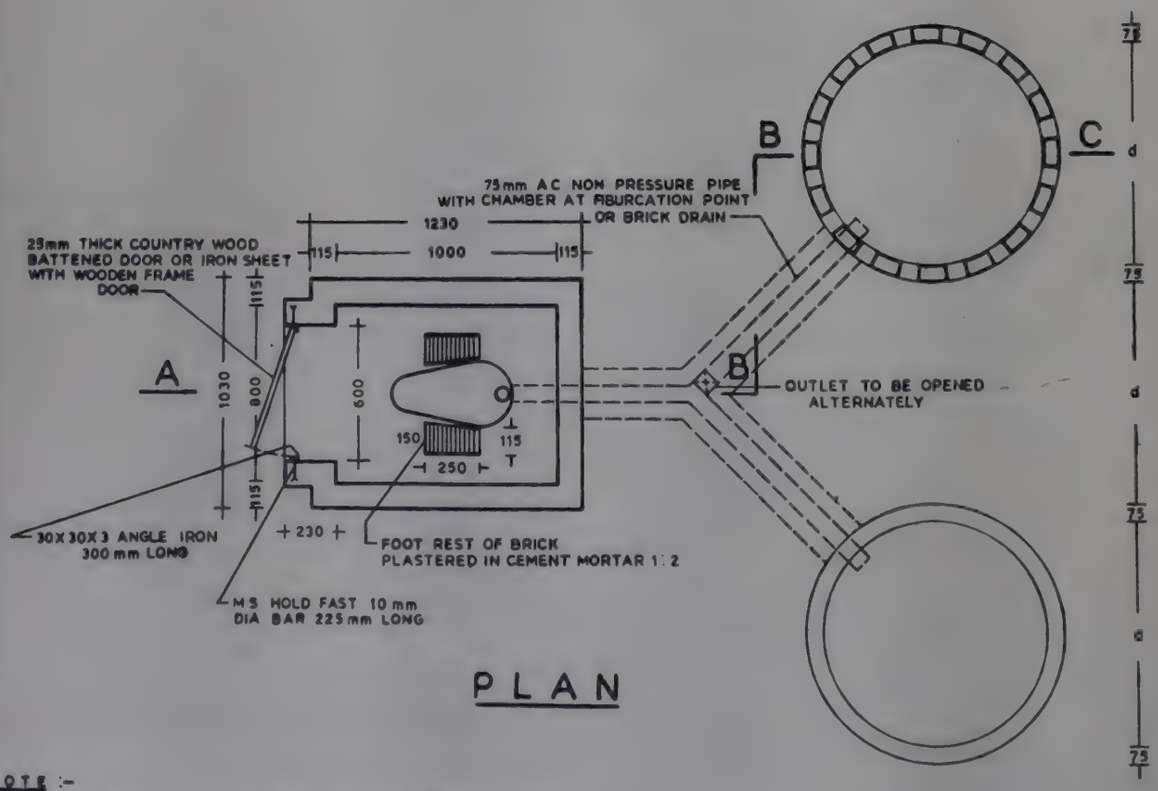
DRAWING NO. 5


75mm R C C 1:2.4 LINTEL
60 mm R C C SLAB 1:2:4, 10 Nos 6mm DIA BARS BOTH WAYS
OPENING(DETAIL AT 'X')
30X30X3 ANGLE IRON 1500 mm LONG
12mm CEMENT PLASTER IN 1:6(OUTSIDE)
1950
1800
1800
12mm PLASTER IN CEMENT MORTAR 1:4 UPTO 300mm HEIGHT FINISHED SMOOTH WITH CEMENT PUNNING
FIBRE GLASS OR PVC PAN
25mm CEMENT CONCRETE 1:2:4 OVER 75mm BRICK BALLAST MIXED WITH SAND DULY COMPACTED AND TOP FINISHED SMOOTH
BRICK COVER LAID IN MUD MORTAR
RCC SLAB 1:2:4
PIT LINING TOP PLASTER IN CEMENT MORTAR 1:6
225
EARTH FILLING
BRICK
225
BRICK BALLAST MIXED WITH SAND DULY COMPACTED
SLOPE 1:10 TO 1:15
BRICK WORK IN CEMENT MORTAR 1:6
HONEY COMB BRICK LINING IN CEMENT MORTAR 1:6 WITH SOLID BRICK LAYERS IN BETWEEN IN CEMENT MORTAR 1:6
h
d
EARTH BASE
1100
+75+75+75+75+75+75+75+
225
'X'

DETAILS OF OPENING

Scale 1:20

SECTION ON A-B-C



PLAN

NOTE :-
FOR PRIMARY HEALTH CENTRES AND SCHOOLS ADOPT 15 USER PITS AND FOR ANGANWADIS, PANCHAYAT OFFICES AND OTHER INSTITUTIONS ADOPT 10 USER PITS

USERS	d	h	t	NUMBER OF SOLID RINGS (BRICK LAYER) AND HEIGHT OF CENTRE OF RING FROM PIT BOTTOM
10	1000	1000	60	2 , 403 , 748
15	1250	1100	75	3 , 403 , 633 , 863

UNICEF/UNDP RURAL SANITATION PROJECT

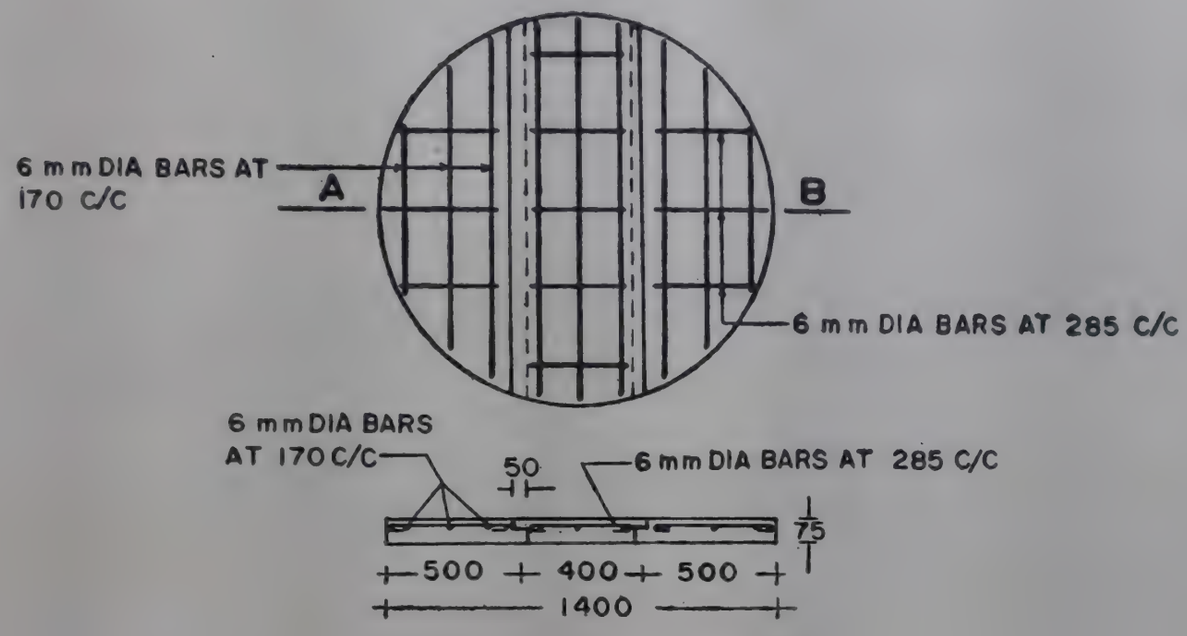
DESIGN OF WATER-SEAL POUR-FLUSH LATRINE

FOR INSTITUTIONS

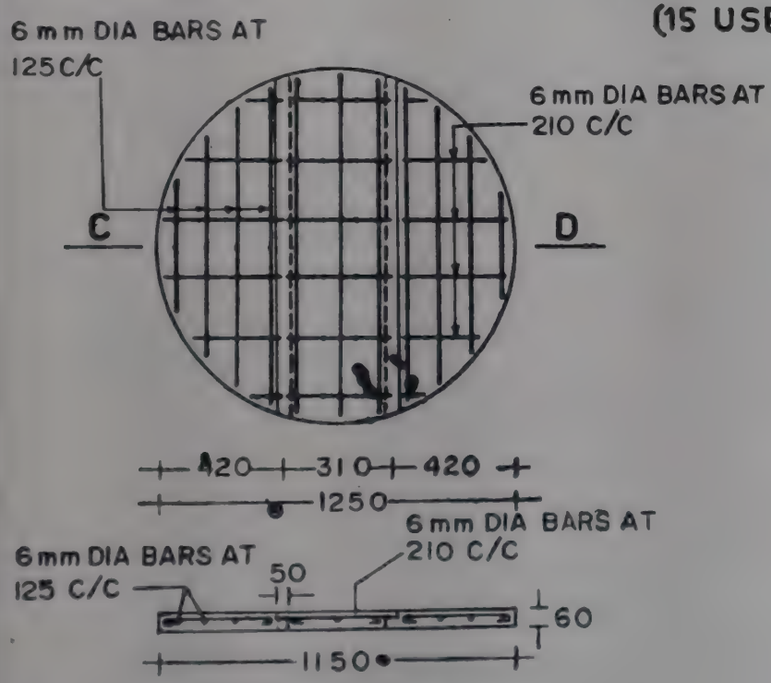
Scale- 1 : 40

ALL DIMENSIONS IN mm

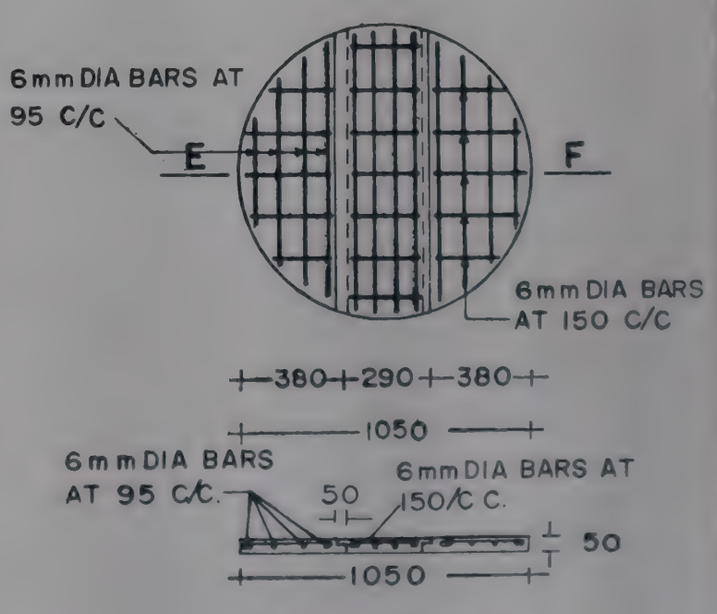
DRAWING No.6



SECTION ON AB
(15 USERS)



SECTION ON C D
(10 USERS)



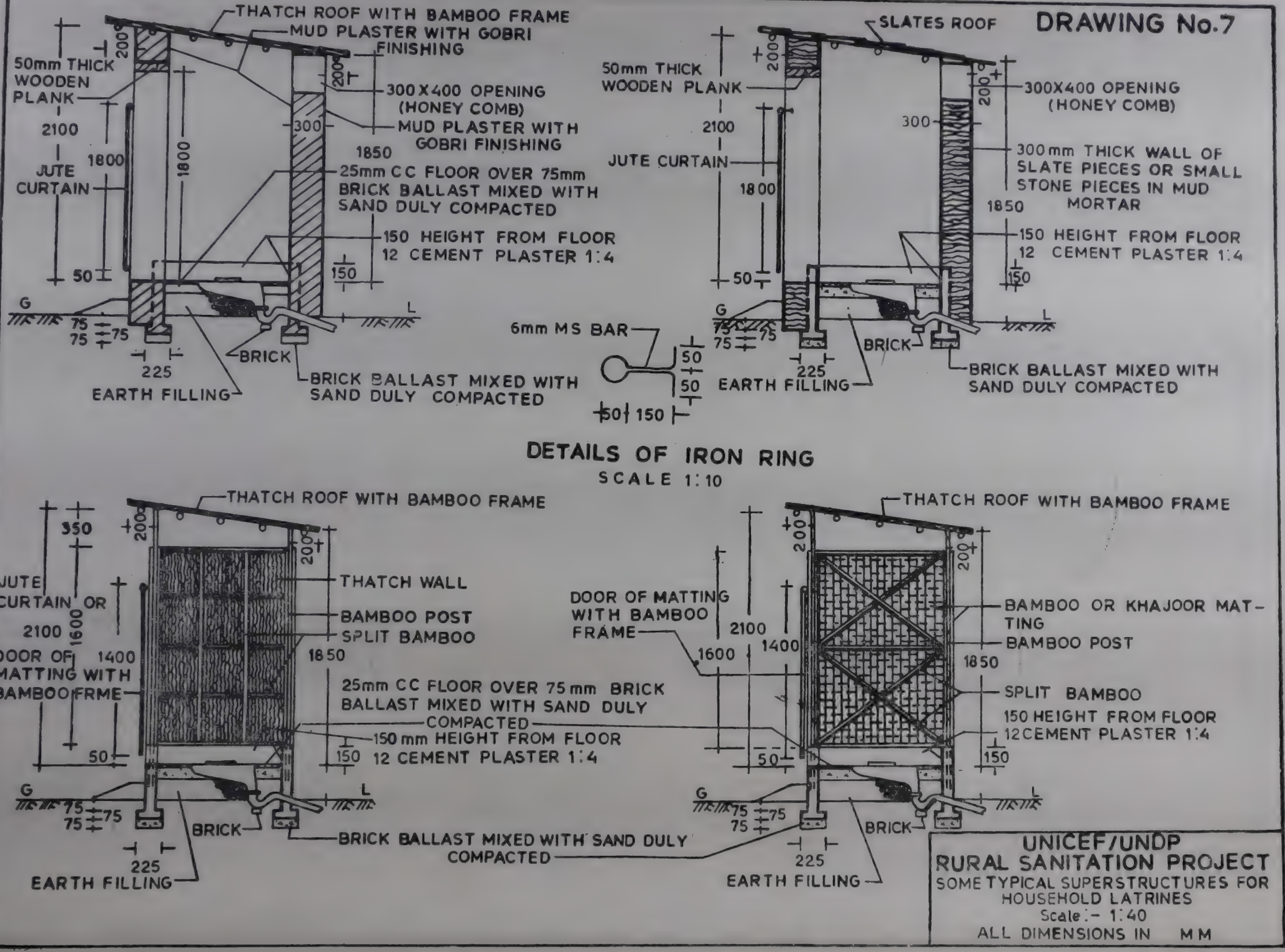
SECTION ON EF
(6 USERS)

ALL DIMENSIONS IN M M

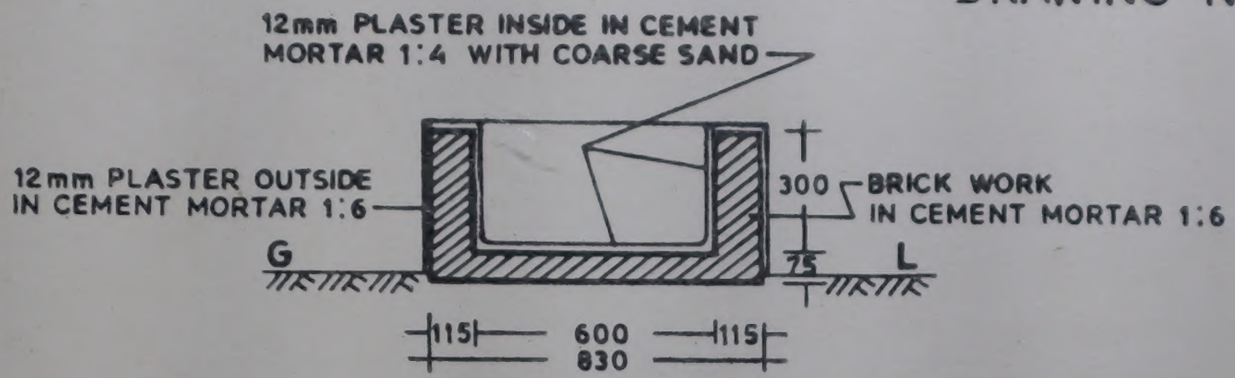
UNICEF/UNDP RURAL SANITATION PROJECT

REINFORCEMENT DETAILS OF R.C.C. SLAB COVER FOR PITS WITHIN PREMISES

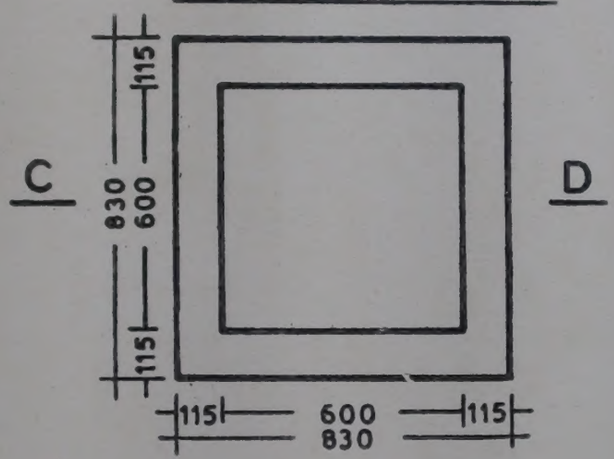
Scale-1:30


DRAWING No.7
THATCH ROOF WITH BAMBOO FRAME
MUD PLASTER WITH GOBRI FINISHING
50mm THICK WOODEN PLANK
2100
JUTE CURTAIN
1800
300X400 OPENING (HONEY COMB)
MUD PLASTER WITH GOBRI FINISHING
25mm C C FLOOR OVER 75mm BRICK BALLAST MIXED WITH SAND DULY COMPACTED
150 HEIGHT FROM FLOOR 12 CEMENT PLASTER 1:4
BRICK
BRICK BALLAST MIXED WITH SAND DULY COMPACTED
EARTH FILLING
SLATES ROOF
300mm THICK WALL OF SLATE PIECES OR SMALL STONE PIECES IN MUD MORTAR
6mm MS BAR
DETAILS OF IRON RING
SCALE 1:10
THATCH WALL
BAMBOO POST
SPLIT BAMBOO
JUTE CURTAIN OR DOOR OF MATTING WITH BAMBOO FRME
DOOR OF MATTING WITH BAMBOO FRAME
BAMBOO OR KHAJOOR MATTING
UNICEF/UNDP
RURAL SANITATION PROJECT
SOME TYPICAL SUPERSTRUCTURES FOR HOUSEHOLD LATRINES
Scale:- 1:40
ALL DIMENSIONS IN MM

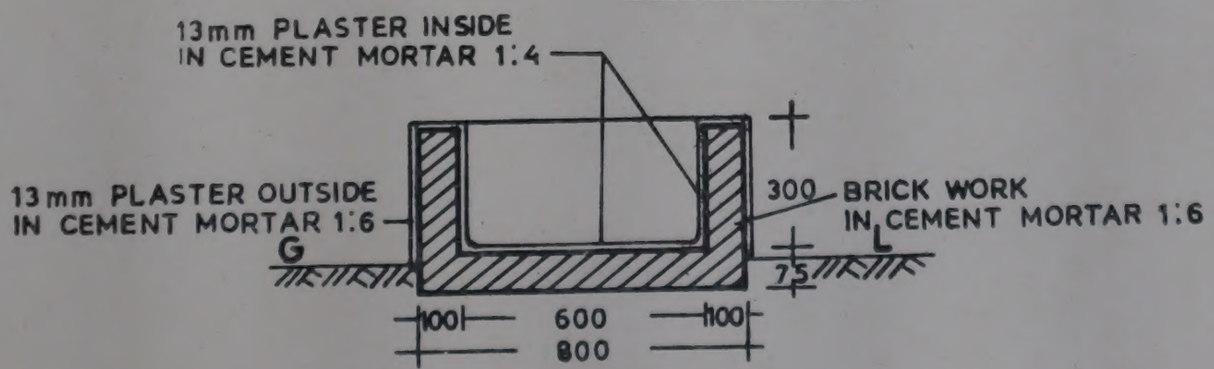
DRAWING No. 8



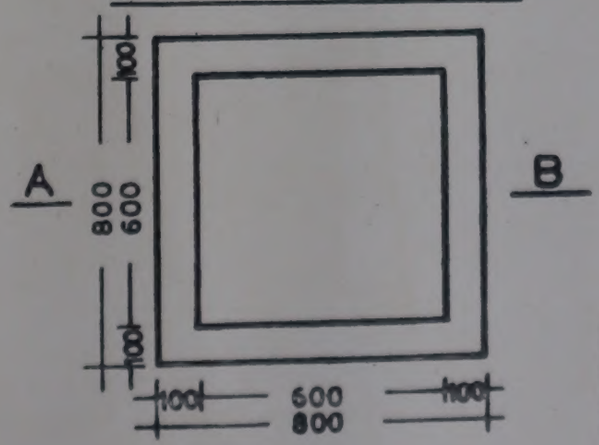
SECTION ON C-D



PLAN



SECTION ON A-B



PLAN

GOI/UNICEF/UNDP RURAL SANITATION PROJECT

DESIGN OF WATER CONTAINER OUTSIDE THE LATRINE IN INSTITUTIONS

SCALE :- 1:20

ALL DIMENSIONS IN MM